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CONTENTS:

	PAGE
The Electromotive Force and Current Curves of the Alternator	609
On Economy in Conductors and the Limitations in the Applicability of Kelvin's Law	611
Carborundum	613
Arc Lamps in Cotton Mills	613
The Coal Question and the Fuel Economiser	614
Re Gold and Cyanide of Potassium	614
Electric Brakes	615
Theory and Practice in Electrical Engineering	615
Experiments in the Utilisation of Chemical Energy for the Production of Electricity (*illus.*)	616
The National Telephone Company's New Exchange (*illus.*)	618
Domestic Electric Lighting Plants	620
Correspondence:—Expert Evidence	621
Electro-Deposition of Gold	621
Cyanide and Electrolytic Cyanide Solutions	621
Central Station Book-Keeping	621
A Dry Pocket Accumulator	622
Designing of Large Alternators	622
Wanted, A Conversion Table	623
The Electric Lighting of Donnybrook Fair	623
Loans for Municipal Electric Lighting	623
Canada and the Pacific Cable	624
Future Electrical Developments	624
The Board of Trade Inquiry into the City Accident (*illus.*)	624
Business Notices, &c.	627
Contracts Open and Closed	629
Notes	630
City Notes	633
Traffic Receipts	633
Share List of Electrical Companies	634
Electrolysis in the Urethral Stricture (*illustrated*)	635
Proceedings of Societies:—Physical Society	638
The Northern Society of Electrical Engineers	638
New Patents	640
Abstracts of Published Specifications	640

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THE ELECTROMOTIVE FORCE AND CURRENT CURVES OF THE ALTERNATOR.

AN interesting contribution to our knowledge of the alternating current dynamo appears in No. 3, Vol. viii., of the *Memoirs and Proceedings* of the Manchester Literary and Philosophical Society, and is the work of Mr. Julius Frith. He undertook experiments with a view to finding out how far the actual behaviour of these machines follows the laws deduced for them from the theory of the alternator; and, if the electromotive force and current deviate from the theoretical sine curve, how many of the Fourier's expressions should be taken into account.

The machine chosen for experiment was a Wilde alternator consisting of two crowns of cast-iron facing each other, from the internal surfaces of which the fixed coils project, six in number, on each side. These are bobbins of wire wound on iron cores. The armature revolves between them, and consists of six similar bobbins on tubular iron cores held in position between two discs of brass keyed on to the shaft. The six coils of the armature are connected in series in the commutator. On the end of the shaft, beyond the commutator, is keyed an ebonite disc; in a slot cut in this, a wide piece of copper is fixed and turned down flush with the ebonite. On this disc bear two insulated brushes side by side; and it will be realised that at one instant in every revolution these two brushes are connected together, while remaining insulated from the rest of the machine. If one of these brushes is connected to one pole of the dynamo, and wires are taken from the other brush whilst the other pole of the machine is connected to an electrometer, the latter becomes connected to the poles of the dynamo at one definite point in the revolution of the armature. This point is known, and can be altered by the arm which carries the two insulated brushes moving round a fixed divided circle.

By means of the above arrangement the E.M.F. curves at the terminals of the machine can be obtained. To obtain the current curves, Mr. Frith made use of the fact that the current in a non-inductive resistance is in phase with, and proportional to, the E.M.F. at the terminals of the resistance. Therefore, if the electrometer can be connected through the same intermittent contact apparatus to the terminals of an ohmic resistance, the form of the current curve can be obtained—assuming that the current curve follows the pressure in form and phase. A Mascart's electrometer was employed, and so arranged that the deflection was directly proportional to the difference of potential between the needle and the frame.

To obtain the magnetisation curve of the iron of the field magnets, a flat coil of 12 turns of wire was wound, and arranged so that it could be suddenly withdrawn from between the coils and the armature, when the latter was at

rest with its coils in a line with the field coils. The ends of this coil were connected to a ballistic galvanometer, and the "kick" observed for different values of the magnetising current on suddenly withdrawing the coil.

By these methods a number of curves were obtained, showing the E.M.F. and the current variations. These curves, which are accompanied by some geometrical analyses, show that the self-induction of the armature decreased with the increase of magnetisation of the iron in the cores—a result which agrees with the measurements of self-induction made in the ordinary way with the machine at rest. On taking power from the machine, the irregularities in the curve die out, and it becomes at first nearly straight from the maximum in one direction to the maximum in the other, and then gradually approaches the sine curve. Curves are also given which were obtained by passing the current through a copper-plating bath, and through an arc lamp. There is also an exceedingly interesting plate, which shows the surging of the lines of force of the field magnets. This was measured by fitting over one of the field coils a light wooden frame, carrying 155 wires stretched radially across the face of the pole in the air-gap between the fields and the armature. The surging of the lines past these wires induced in them an E.M.F., which was measured in the usual way by the electrometer through the intermittent contact apparatus. The induced E.M.F. was found to be proportional to the rate of motion of the magnetic field; and this motion must in a large degree account for the deviation of the E.M.F. and current curves from simple sine curves. Mr. Frith deduces from his results that, for the case of an alternator whose armature contains iron, at least three terms of the Fourier's expression must be considered; but most especially the third, the second being in most cases comparatively small.

The E.M.F. curves may be taken as correct in these tests, and show that this machine has a large armature reaction. This is confirmed by the tests showing the surging of the field magnetism; the deformation of the curves is due also to the armature reaction and the eddy currents in the cores. To put Fourier's expressions to a crucial trial, a machine in which eddy currents and armature reactions are reduced to a minimum, or accurately ascertained in value, should be used; but the curves given are of interest, as they show the deformations exaggerated by the primitive construction of the machine used.

The Direct Production of Electricity from Fuel.

The contribution by Dr. Borchers, which we give in another place on this question, will be read with interest by many who have attempted to devise some method of converting the energy of combustion directly into electrical energy. Gas batteries, after the model of Grove's have been tried, hitherto, for the direct production of electricity from fuel with very little success; the current has been found to fall off very rapidly. In Borchers's gas element this difficulty appears to have been overcome, for no falling off of the current has been observed. This in itself would be a great step, but the numbers which have been obtained for the efficiency of the arrangement as compared with the steam engine and dynamo, at present used for producing electricity, are still more remarkable. As much as 30 per cent. of the heat energy of the fuel was converted into electricity with the rough apparatus employed in these experiments. The average efficiency of the steam engine is 7 to 8 per cent. The actual output of the new gas element appears to be very small, and it is just possible that the first cost and cost of maintenance of an installation of gas elements may more than counter-balance the increased efficiency. This element appears to fulfil the requirements of the ideal battery as laid down recently by Ostwald:—"The carbon element of the future must have the oxidising agent at a different place from that where the carbon is burnt, and this agent must either be the oxygen of the air, or some oxidiser that can be easily obtained from it. Such an element would show exactly the same chemical process as an ordinary furnace, at one side carbon is poured in, at the other side oxygen has to be supplied, and carbonic acid gas is the product of their mutual action. Only a suitable electrolyte must be interposed which will promote the electrical process. This electrolyte will only act as an intermediary and will itself undergo no consumption."

An Application of Electrolysis to Chemical Analysis.

Workers in chemical laboratories where electric current is available—as it should be now in every well appointed laboratory—will welcome a simple and ingenious method of estimating the halogens by means of electrolysis. It is described in full in the *Monatshefte*, xv., pp. 280—284, but the essential features of the process may be briefly dealt with. A dense "reguline" deposit of silver haloïd is obtained when a halogen is deposited on a weighed silver plate from an alkaline solution. The solution of the halogen is mixed with a few grammes of alkali tartrate and 10 per cent. of sodium hydroxide solution, and then subjected to a current of 2 volts and 0·03—0·07 ampère. The cathode is of platinum, the anode of silver. The latter after removal from the solution is washed with water, and then with alcohol and dried; it is finally heated until the silver haloïd melts or darkens, after which it is cooled and weighed. G. Vortmann, to whom this method is due, states that if very accurate estimation is required it is necessary at the end of the operation to substitute a platinum electrode for the silver anode, and again pass the current for one hour in order to deposit the small quantity of silver which is dissolved.

An Electrode Sensitive to Light.

In the *Zeitschrift für Physikalische Chemie*, H. Luggin describes a new form of electrode which he claims to be much more sensitive to light than any that has hitherto been made use of in previous investigations. Briefly, its essential features are as follows: A plate of platinum is coated with silver bromide and is then duplicated with a similarly coated platinum plate in an aqueous solution of bromide of potassium (decinormal). A quadrant electrometer of the usual type is employed in observing the rise of potential. Luggin states that in some of his experiments exposure to diffused daylight was sufficient to cause a rise of potential of 0·5 volt, thus demonstrating the great usefulness of this new form of electrode. When illuminated by any weak light it appears that this electrode shows a rise of potential which is uniform, and can be represented graphically in a system of co-ordinates by means of a straight line until a maximum is reached, after which it remains constant or may show a slight fall. The rate of increase of potential is much more marked when stronger light is employed, but for all that the maximum value attained is not higher. The rate of rise, however, is not directly proportional to the intensity of the impinging light, whilst it is also lowered by a previous exposure of the electrode to a powerful light. Continuous and intermittent lights of the same intensity do not appear to produce the same effect on the potential. These plates, though ingenious and likely to become exceedingly useful in certain investigations, do not remain constant as regards their sensitiveness, and even after long rests they show with the same sources of light very different increases of potential. Therein, we presume, consists their only weakness.

ON ECONOMY IN CONDUCTORS AND THE LIMITATIONS IN THE APPLICABILITY OF KELVIN'S LAW.*

By WM. A. ANTHONY.

In 1881 Lord Kelvin read before the British Association a most interesting and important paper upon the conditions leading to the greatest economy in the transmission of electric energy, and gave as the result of his investigation that the greatest economy is secured when the cost of the power wasted is equal to the cost of interest, depreciation, repairs, &c., on that part of the cost of the line that increases with the cross-section of the conductor. This was pretty generally understood to be a general law, but Prof. Ayrton pointed out some eight years ago, in a paper read before the Society of Telegraph Engineers, that it is only in certain cases that the law holds good. That paper, however, does not seem to have been very widely read, and the idea seems still to prevail that Kelvin's law has a general application. For this reason, and not because I expect to add anything new to the subject, I venture to call attention to the matter.

In the electrical distribution of energy several cases may arise, depending upon the purpose for which the energy is to be used, the conditions that affect the generation, considerations of safety, &c., and each of these cases must be treated according to the conditions that determine it.

Suppose the energy is to be used for incandescent lighting at some distance from the generating station. The energy to be delivered at the receiving station is then given, the pressure at the receiving station and, therefore, the current, are also fixed.

Let w be the power in watts to be delivered, and v the pressure at the receiving station.
„ P be the power and
„ V the pressure at the generating station.
„ I = the current on the line.
„ r = the resistance of the line ; and
„ l = the length of the circuit, that is, twice the distance the power is to be transmitted.
„ k = the cost of 1 watt-year delivered to the line ; and
„ c = the cost per year for interest, repairs, &c., on a mile of conductor measuring 1 ohm in resistance—this to include all the items of cost that increase in proportion to the cross-section of the conductor.

Leaving out of account all considerations relating to the variable use of the power, the problem to be solved is simple. We have a fixed quantity of power to deliver. We must, of course, provide for its generation. We must transmit this power to the receiving end, and we wish to do this at the least possible cost.

The cost for one year of the energy required for transmission is $k\,\mathrm{I}^2\,r$.

The cost for interest, &c., for one year is $c\frac{l^2}{r}$.

The total cost of transmitting the power, w, for one year is, therefore,

$$k\,\mathrm{I}^2\,r + c\frac{l^2}{r} \qquad (a)$$

and we wish to make this the least possible.

Since I is fixed by the conditions of the problem, the only variable in the above expression is r, and it is required to so vary r that the cost represented by the expression shall be a minimum. Differentiating with respect to r, and equating the coefficient to zero, we have

$$k\,\mathrm{I}^2 - c\frac{l^2}{r^2} = 0. \qquad (1)$$

Multiplying both terms by r,

$$k\,\mathrm{I}^2\,r = c\frac{l^2}{r} \qquad (2)$$

which is Kelvin's law.

Solving (1) for r,

$$r = \frac{l}{\mathrm{I}}\sqrt{\frac{c}{k}} \qquad (3)$$

and

$$\frac{r}{l} = \frac{1}{\mathrm{I}}\sqrt{\frac{c}{k}} \qquad (4)$$

But $\frac{r}{l}$ is the resistance per mile of the conductor and the equation shows that it is independent of the length of the conductor, or the distance of transmission. This was one of the surprises in Lord Kelvin's paper.

Now note the conditions under which this result was reached. An installation of incandescent lamps is to be supplied ; w, v, and I are given quantities.

P, V, and r can be varied to meet the conditions imposed by considerations of economy.

Take another case. A fixed quantity of power is to be delivered to a distant motor, but considerations of safety, possibility of insulation, or some other consideration, limits the pressure upon the line. This limit will of course apply to the generating end of the line where the pressure is highest, hence V is a given quantity. V may also be fixed on account of taking the current from an existing system. Just as before, we have a given power to deliver and we wish to transmit it at the least possible cost. The cost of transmission is, as before,

$$k\,\mathrm{I}^2\,r + c\frac{l^2}{r} \qquad (a)$$

The problem *seems* to be the same as the former. The only apparent difference is that I is unknown. The relation between I and the other quantities is given by the equation

$$w = \mathrm{V}\,\mathrm{I} - \mathrm{I}^2\,r. \qquad (5)$$

Let us assume that Kelvin's law applies to this case ; then

$$k\,\mathrm{I}^2\,r = c\frac{l^2}{r} \qquad (2)$$

We now have two equations from which I and r may be obtained.

Substituting the value of r from (2) in (5)

$$w = \mathrm{V}\,\mathrm{I} - \mathrm{I}\,l\sqrt{\frac{c}{k}} \qquad (6)$$

$$\mathrm{I} = \frac{w}{\mathrm{V} - l\sqrt{\frac{c}{k}}} \qquad (7)$$

Assume that 10 H.P. is to be delivered to a motor at a distance of 20 miles from a 500-volt circuit ;

$$\mathrm{V} = 500 \text{ volts} ; \quad w = 7{,}500 \text{ watts} ; \quad l = 40 \text{ miles}.$$

Taking the cost of a horse-power delivered to the line at \$50 per year, $k = \frac{1}{75}$th of one dollar. Take the cost of copper measuring one ohm per mile as \$100 per mile, then,

$$c = 10 ; \quad \frac{c}{k} = 150 ; \quad \sqrt{\frac{c}{k}} = 12\tfrac{1}{4} \text{ very nearly.}$$

Substituting these values in (7) we have :

$$\mathrm{I} = \frac{7{,}500}{500 - (40 \times 12\tfrac{1}{4})} = \frac{7{,}500}{10} = 750.$$

From (3) $r = \frac{40}{750} \times 12\tfrac{1}{4} = \frac{49}{75} = \cdot 65 +$

Volts lost on line, $750 \times \frac{49}{75} = 490{\cdot}0$

Pressure at motor,	$500 - 490 = 10$ volts,
Power delivered,	$750 \times 10 = 7{,}500$ watts,
Power generated,	$750 \times 500 = 375{,}000$ watts,
Wasted in line,	$375{,}000 - 7{,}500 = 367{,}500$ watts,

or 490 H.P. wasted to obtain 10 H.P.—not a very economical transmission !

If we substitute the value, $r = \frac{49}{75}$ in (5), and solve for I, we have

$$7{,}500 = 500\,\mathrm{I} - \frac{49}{75}\,\mathrm{I}^2.$$

$$\mathrm{I} = 750 \text{ or } \frac{750}{49}.$$

The last value satisfies eq. (5) but does not satisfy Kelvin's law, eq. (2).

* New York *Electrical Engineer*.

With this last value of I, we have:

Volts lost on line $= \frac{49}{75} \times \frac{750}{49} = 10$ volts.

Pressure at motor $= 490$ volts.

Power delivered, $490 \times \frac{750}{49} = 7{,}500$ watts.

Power generated, $\frac{750}{49} \times 500 = \frac{375{,}000}{49}$ watts.

Wasted in line $\frac{750}{49}(500 - 490) = \frac{7{,}500}{49}$ watts.

The required power is delivered with the same initial pressure, over the same line, by means of a current $\frac{1}{49}$ as great as Kelvin's law calls for, and with a loss of energy on the line $\frac{1}{(49)^2}$ as great as would satisfy Kelvin's law. Kelvin's law, therefore, does not in this case give the most economical value of the current. Taking the value $I = 750$, the cost of transmission is

$$k\,I^2\,r + c\frac{l^2}{r} = \frac{1}{15}(750)^2 \times \frac{49}{75} + 10 \times 40^2 \times \frac{75}{49}$$
$$= \$24{,}500 + \$24{,}500 = \$49{,}000 \text{ per year.}$$

Taking $I = \frac{750}{49}$, the cost is $500 + 24{,}500 = \$25{,}000$ per year.

It will be shown that neither of these solutions is the correct one. The fallacy lies in the fact that the solution for the minimum value of the expression for the cost of transmission

$$k\,I^2\,r + c\frac{l^2}{r}, \qquad (A)$$

does not give Kelvin's law except when r is the only variable, while in the case under consideration I and r are both variable, dependent on each other by the relation given in equation (5).

Eliminating r from (A) by means of (5) we get

$$k\,(V\,I - w) + \frac{c\,l^2\,I^2}{V\,I - w}.$$

Solving for I = a minimum

$$I = \frac{w}{V}\left\{1 \pm \frac{\sqrt{\frac{c}{k}l^2}}{V^2 - \frac{c}{k}l^2}\right\} \qquad (8)$$

Using same values as before

$$I = \frac{7{,}500}{500}\left(1 \pm \sqrt{\frac{150 \times 1.600}{250{,}000 - 240{,}000}}\right).$$

$I = 88{\cdot}5$, $r = 4{\cdot}69$.

Volts lost on line, 415·15.

Pressure at motor, 84·85.

Power delivered, $84{\cdot}85 \times 88{\cdot}5 = 7{,}500$ watts.

Power generated, 44,250.

Wasted on line, 36,750.

Cost per year for transmission,

$$\frac{1}{15} \times 36{,}750 + 10 \times (40)^2 \times \frac{1}{4{\cdot}69} = 2{,}450 + 3{,}411$$
$$= \$5{,}861.$$

Cost per year for transmission if conductors are computed by Kelvin's law, \$49,000.

These figures tell their own story.

Take another case. A water-power is available at a distance from a point where the energy can be utilised. The power available is fixed and it is desired to use it all to the best advantage. The pressure is limited by considerations of line insulation. Hence P and V, and, therefore, I are given. The problem now is, not to deliver a certain fixed quantity of energy at the least possible expense for transmission in the form of additional energy and interest and repairs on line, but to divide the energy available into two parts, one to be delivered and the other to effect the transmission, such that the returns from the part transmitted shall bear the largest possible ratio to the total cost of generation and transmission. The application of Kelvin's law to this case might, and often would, give a size of conductor such that the entire available energy would be consumed in it.

The available power is $P = V\,I$.

The power wasted is $I^2\,r$.

The power that can be sold is $V\,I - I^2\,r$.

If this is worth n dollars per watt per year its value is $n\,(V\,I - I^2\,r)$.

The total cost of generating the power is $k\,V\,I$. The cost of interest and depreciation, &c., on the line is $c\frac{l^2}{r}$. Hence the ratio of the revenue from power sold to the total cost of generation and transmission is

$$\frac{n\,(V\,I - I^2\,r)}{k\,V\,I + c\frac{l^2}{r}} \qquad (9)$$

It seems self-evident that we shall be doing the best possible with our available energy, when the resistance and cost of the line are so adjusted that the above fraction becomes a maximum.

In this case the gain as compared with the results given by Kelvin's law is not very marked except when that law gives a conductor that wastes a large proportion of the available energy. Since the cross-section of the conductor is in this case the only variable, Kelvin's law gives the minimum value for the sum of the waste energy and the interest, &c., on the line. But of what avail is it to reduce that sum to a minimum when by so doing all, or nearly all, the available energy is wasted? It is better to spend more for interest and depreciation, and have some power left to dispose of. By giving to r such a value that the value of the expression (9) becomes a maximum we obtain the largest possible proportion of revenue to expenditure.

Other cases might arise, each requiring its own solution. We might, for instance, have a given amount of power at the generator to be delivered at a given pressure at the receiver. The pressure at the generator and the size of the conductor might be the given quantities. There are in all eleven different cases, most of which may be solved for a condition of maximum economy, but in only one is the condition of maximum economy satisfied by the conditions given by Kelvin's law. The condition of maximum economy of course does not always lead to a practical solution. The conductors given might in some cases run too hot; the power that could be delivered might, at best, cost more than could be obtained for it; but these are considerations that must be dealt with separately. As already intimated, it seems to me a self-evident proposition that the maximum economy is reached in any case when the revenue from the energy delivered bears the largest possible ratio to the total expense of generation and transmission. When the energy to be delivered is given, the condition of maximum economy is that the cost of transmission shall be a minimum. The cost of transmission is made up of two items, viz., (A) the cost of the energy required to effect the transfer and (B) the cost for interest and depreciation on the line. (A) is proportional to $I^2\,r$ and (B) is proportional to $d + \frac{l}{r}$ where d is that portion of the expense on the line that does not vary with the size of the conductor. Now suppose I to be given by the conditions of the problem; then the item (A) varies as r, and the variable portion of (B) varies as the reciprocal of r. In other words the product of these two items is constant. It is well known that in such a case the sum of the two quantities is a minimum when the quantities themselves are equal, which leads us at once to Kelvin's law.

But suppose I is not given by the conditions of the problem, but is a variable as well as r; then the sum of the two items depending respectively on $I^2\,r$ and $\frac{l}{r}$ is no longer a minimum when they are equal, but, as I have shown, making them equal may give a sum many times the minimum value.

When the quantity of energy that can be generated is given, the condition of highest economy no longer requires that the cost of transmission shall be a minimum, since making it a minimum might in some cases demand the entire available energy to effect the transmission.

Let me say here that I do not know how we have fallen into the habit of calling the energy consumed in transmission "waste energy." It is an entirely legitimate part of the expense of transmitting energy from the generator to the receiver and is no more waste than interest and depreciation on the line are waste. If the line is poorly insulated and leakage occurs along it, the energy so lost might be properly termed waste. In transporting coal from the mines to the consumers no one thinks of calling that part of the coal that is used on the locomotives "waste" coal. Why should we call that part of the electric energy that is used for transmission "waste"?

My object in this article has not been to give an exhaustive treatment of the subject, but merely to point out the general principles upon which solutions are to be based and to indicate that the different cases that arise lead to totally different results.

CARBORUNDUM.

This new material first saw the light of day in 1890, in the course of some experiments made by Edison with the view of manufacturing diamond, or to speak more modestly, crystallised carbon. The process of manufacturing carborundum has since been perfected by Mr. E. G. Acheson, chairman of the Carborundum Company. The purpose of the experiments, in the first place, was to dissolve carbon in silicate of alumina by means of a powerful electric current. An experiment was made in a furnace whose walls consisted of refractory material; into each end of the small furnace carbon electrodes projected. These were connected to an electrical apparatus capable of supplying a current of 100 to 200 ampères. The colour of the crystals obtained was usually blue, and their hardness was very great. They were not at this time analysed, and it was thought from their sapphire blue and ruby red colours, and their hardness and general form, that the new material was a compound of carbon and alumina. Hence it was christened "carborundum," a contracted form of "carbon" and "corundum." Later it was discovered by analysis that the true components of the material were carbon and silicon, but the old name was still retained.

Further experiments showed that the silica in the furnace played a most important part in the process. A mixture of 40 per cent. carbon, 40 per cent. silica, and 20 per cent. common salt, was then charged into the furnace. The salt had been found to very much facilitate the process of fusion in former experiments. The carbon was made by pulverising the carbons used in arc lamps, which, as is well known, are made from the residues of the distillation of petroleum. For silica, the sand used in glass manufacture was used. The electric plant, mentioned above, was set in operation, and the current turned on to the furnace. Various gases and vapours were given off, till the completion of the process was indicated by the fall in the current strength.

The crystals obtained were purified by treatment with hydrochloric acid and caustic soda, washed and exposed to the action of a current of oxygen at a red heat. After treatment with hydrofluoric acid, a powder was obtained which showed only traces of impurity.

With the improved furnace at present in use, as much as 100 lbs. of carborundum can be produced a day. Several improvements have been introduced in the purification process, but there still appears to be room for a considerable improvement in the economy of production.

The most important uses of the product may not yet have been discovered, but at least it has some properties which alone undoubtedly will make it of the greatest importance in the arts. It is infusible and uncombustible, and, what appears to be of most importance, of a hardness exceeding that of any known material, except diamond.

In the *Electro-Techniker* (Vol. xiii., No. 10) is given an interesting account of some practical tests of the value of carborundum as a grinding and polishing material by the firm of Messrs. Eduard Frey, in Vienna. The small carborundum wheels tested by them were found to far excel the best Naxos emery wheels for grinding glass, most stones, and the hardest cast-steel. A quite remarkable property of the carborundum was the small amount of wear, a fact which will greatly enhance its value for the production of accurate work. Another great advantage was, that the hardest steel tools could be ground dry without developing heat sufficient to produce the slightest effect on their temper. It is well known that with emery wheels this is not the case. Large wheels do not appear as yet to have been made of carborundum, but there appears to be no reason why this should not be successfully done.

A specially important question about a newly introduced article is its price. According to the American price lists, carborundum appears to be four times as dear as emery for the larger wheels, and five times as dear for the smaller wheels. Emery, however, is at present very cheap.

A large factory for the manufacture of carborundum has recently been established in Bohemia. The Naxosschmirgelwerk Union, at Frankfort-on-Main, have recently produced a new product, which they call carbonit-carborundum, and which is said to excel carborundum in durability, without any loss of sharpness. It also can be used with larger grains, and is cheaper.

Though all the expectations from these discoveries may not be realised, yet sufficient appears to be established to claim for electrotechnics a new triumph, and to point the way to further advances.

ARC LAMPS IN COTTON MILLS.

The use of arc lamps in cotton mills, upon what is known as the "inverted arc system" of lighting, is slowly but surely making headway in this country. Owing to the murky atmosphere which prevails in our manufacturing districts, where cotton mills most do congregate, and where the sun is rarely seen, there is need for artificial light during the greater portion of the working hours, hence the question of lighting is a very important one, not only for mill owners but also for mill hands. Gas at its best is a poor substitute for daylight, and is further objectionable on sanitary grounds. The advent of incandescent electric lighting was a great improvement, no doubt, both as regards safety and health, but it still left much to be desired as a light for mill purposes. Arc lighting, as then known, was found unsuitable on account of the hard shadows cast, and furthermore was regarded as unsafe, and consequently practically prohibited by the fire offices.

The first attempt at mill lighting by arc lamps upon a rational system emanated, if we mistake not, in France. This simply consisted in suspending an inverted cone reflector below the arc, thus throwing the light first upon the whitened ceiling above, and thence upon the work below. By thus doubly reflecting the light, and at the same time shielding the eye from the direct rays, the effect was most pleasing, the perfect diffusion thus attained practically destroying all shadow. The next advance was to invert the arc itself by placing the crater carbon below, and in this form we have what is known as the "inverted arc" system of lighting. So much is the new light appreciated—rivalling daylight itself—that mill owners readily pay the extra tax imposed by the fire offices rather than be without it. At the same time it must be admitted that great care is needed when introducing arc lamps in the presence of such highly inflammable material as cotton, and upon this score we venture to offer a few remarks.

There are two cases on record of serious fires in cotton mills traceable to arc lighting. In the first case the usual netted glass globe had alone been relied upon for protection, and owing to some imperfect construction, or, what is more likely, the neglect of the trimmer to replace an injured globe, a particle of heated carbon escaped from the lamp on to the material below, immediately setting fire to the cotton, and resulting in the destruction of the mill. The second case was in connection with the use of an inverted cone reflector suspended below the arc by means of chains, *made detachable to admit of trimming*. The lamp had just been retrimmed, when the cone reflector was seen to tilt violently on one side, dislodging a large particle of the crater carbon on to the mule beneath, setting fire to the cotton, with the same disastrous result to the mill as in the case above quoted. Here again the trimmer either failed to properly reconnect the chain, or else some part of the suspension gear gave way. Now there is a lesson to be learnt

from these two fires. It is evident that glass, or any other such brittle material, should not alone be relied upon as a guard against the escape of heated material from the arc. The necessity for retrimming every six or eight hours during the running of the mill, and frequently under trying circumstances, leads to breakages, which are not always attended to in time; and the bungling or neglect of the trimmer is the one factor most to be feared, as well as the most difficult to provide for. Glass of any kind is therefore better dispensed with. It absorbs much light, particularly when coated with dust, and casts unpleasant shadows. The supposition that there is danger in a naked arc burning in an atmosphere charged with fine cotton flyings, has been proved groundless, and experiments also show that the dust which collects within the reflector is impotent to do harm. In fact, it appears, that the one and only danger to be apprehended is the possibility of a considerable particle of the incandescent carbon coming in contact with the material itself. We believe it possible to give all the protection necessary by a well designed and ample metal inverted cone reflector, without the addition of a globe, provided it be permanently and rigidly attached to the body of the lamp. Indeed, it should be a *sine quâ non* in all arc lamps for cotton mill lighting that no essential guard nor any part of the suspension gear need detaching for purposes of adjusting or renewing carbons.

Next in importance is the suspension gear; for should a lamp fall when in use, the result would probably be fatal. Usually the lamp is suspended by a cord or chain, with counterweights, over a couple of small pulley wheels, with considerable wear and tear upon the cord. This, therefore, should be strong, preferably of steel, with well made connections; and as an additional precaution, an independent guard chain is recommended, to prevent the lamp falling beyond a certain distance, in the event of any portion of the suspension gear giving way.

The use of arc lamps in the spinning and carding rooms of cotton and flax mills must always be attended with more or less danger, and only by carefully attending to such details of construction, as we have here briefly alluded to, can that danger be reduced to a minimum.

THE COAL QUESTION AND THE FUEL ECONOMISER.

Under this head we have received a pamphlet from Mr. Jas. A. Calvert, of Manchester, and a note calling attention to some tests shortly to be made at the City of London Electric Lighting Station at Bankside, of the ordinary Green's economiser and of Calvert's circulation economiser. It is pointed out that in the ordinary Green economiser the water is allowed equally free access to every pipe, and that, therefore, the apparatus is of equal temperature throughout, and cannot produce results so good as it should do if the principle of counter currents were adhered to. The circulation economiser, on the other hand, receives its feed at the chimney end where the coldest gases are in contact with the pipes, whence the water rising to the top of the first row of tubes is carried down to the bottom of the second row, and so on through every row of pipes at a very much greater velocity than that of the water in the ordinary type of apparatus, and, finally, the heated water at the boiler end of the series is exposed to the gases as hot as they leave the boiler. Thus the feed is more heated and the gases more cooled than in the ordinary arrangement. Now this is perfectly correct theory, and we have long argued on these lines, but it must be pointed out that in the ordinary type of economiser there is a slight modification in the above action. The circulation in each pipe is very slow, it is true, but the water at the top end of each pipe is exposed to what is in effect the hottest layer of gas from the boiler, and something of the principle of counter currents is thus brought into action. For large plants especially, we are much inclined to favour that modification of the circulation economiser which is now becoming fairly common, and which consists in dividing the total number of pipes into two, three, or more sections, putting these in series, both as to water circulation and their position in the flues, but working the pipes in each section in parallel, as in the old arrangement.

If the first section of such series be, as suggested by Mr. Calvert, an old and weakened economiser through which the feed is pumped under no pressure, then will this old section suffer all the corrosion which is now so grievous a fault in economisers, and eats away the lower sixth of each pipe, while the remaining five-sixths is in good order and equal to new. While, therefore, we are to a large extent in agreement with the reasoning advanced in this very good pamphlet, we would content ourselves rather with a modification of the arrangement as thus indicated.

Mr. Calvert, however, would arrange a separate economiser to each boiler, so as at all times to gain the full benefit of the periods of hottest gases issuing from that special boiler, instead of simply using the mean temperature of the whole battery, as per the mixture of gases in the main flue. In such a case it would no doubt be better that each economiser should work on the circulation system, or, at least, in two series; but in every case, we think the chill ought to be taken off the water by an old apparatus in the main flue before exposing new and costly pipes to the inevitable corrosion that accompanies the placing of cold pipes in a *melange* of flue gases largely composed of steam and sulphurous acid.

Years ago, when boiler pressures were less and the temperature also less, the boiler itself could reduce the temperature of the gases to a very much lower point than is now possible to be done with high temperature boilers, and the single economiser was perhaps a sufficient practical extension of heating surface. Now, however, when steam has a much higher temperature it is quite open to argue that the economiser should be in at least two sections. Mr. Calvert would make as many sections as there are rows of pipe, thus a 320 pipe economiser would have, say, 32 sections, and there would be an addition of only about 6° to 7° of temperature in each section. While correct in principle this is an unnecessary extension of such principle, and the series of fewer groups appears more practical, while sufficiently conforming to correct ideas.

We look forward to the tests promised with interest, but we would point out to Mr. Calvert that we have found many economisers which showed water temperatures very considerably over the 250° (fully half a score years ago), which he inclines to think is considered so very good.

Re GOLD AND CYANIDE OF POTASSIUM.

The electrical press was greatly interested in the lawsuit brought by the Cassel Gold Extracting Company *v.* the Cyanide Gold Recovery Company and others, which involved at the same time the use of cyanide of potassium as a solvent of gold by itself and in combination with the electric current.

The evidence was so strange that we should have liked to give our opinion on what was stated, the more so as just before the beginning of the lawsuit we had an article on this question of the knowledge of cyanide of potassium as a solvent of metallic gold and of gold in its ores, which was in type and ready for publication (see Electrical Review, November 16th, p. 586). Mr. Justice Romer, however, having reserved his decision, we abstained from comments, and we did not even publish some quotations from books which were not mentioned during this remarkable legal case, but which, nevertheless, were important.

It seems that the African Gold Recovery Company did not take any notice of such trifles as this. It did not matter whether the question was *sub judice* or not, and without ceremony, at their last meeting a few weeks ago, the following statement was made and published in some papers, while not one of the electrical papers had a word of criticism on the extraordinary evidence which had been given by scientists and experts:—

"The patentees discovered the special affinity of cyanogen for gold, and disclosed to the world how to apply that principle in a practical and economical way for the extraction of gold from ores. This had never been done before. Others never came near it. Some, adopting in theory the principle

of the well known electro-plating process patented by Elkington, tried to apply this to the treatment of ores; but their processes were crude and unworkable, and gave no practical recovery of gold. They were tried, found unworkable, and abandoned, and, if not forgotten, were acting the part of beacons to warn men away from research in the use of cyanide for the extraction of gold from ore. They discovered no new facts, and conveyed *no knowledge not previously disclosed in the electro-plating process.* It was only in the light of the knowledge the MacArthur-Forrest patent supplied that those previous publications revived into notice, and even with that light they could never be successfully worked, as described in the publications. To be used they *have to be remodelled and converted into the MacArthur-Forrest process, founded upon the selective affinity of cyanogen for gold and silver.* They were mere theories on the lines of electro-plating, and never were, and never could be practically used by the mining industry for commercially recovering the gold from ore. We have ransacked America from east to west, from north to south, traced to its source every scrap of report as to the use of cyanide for extraction purposes, and not one iota of evidence have we found of such use of cyanide by miners previous to MacArthur's disclosures. Any cyanide previously used was for cleaning the amalgamation plates, and not for dissolving gold for extraction purposes. It was used to dissolve the base metals that fouled the plates, and was supposed not to act upon or dissolve the gold in the ore. Scientific men had long known that most metals, including gold, were acted on, more or less, by cyanides, and, it was supposed, the baser metals most. Cyanides had been used for laboratory purposes; but no one had discovered and disclosed their selective action and preference for gold, or disclosed how and by what means cyanogen could be availed of by the miner for extracting the gold from its ores."

How can the shareholders of the Cassel Company reconcile the rosy declarations of their directors with the decision of Mr. Justice Romer?

Is it possible that the Cassel Company entertained the slightest doubt on the result of the lawsuit?

The owners of gold mines in the Transvaal and the Cassel Company have just now buried the hatchet; no lawsuit will take place there, and the Cassel Company, which owns the MacArthur and Forrest patents for the use of cyanide in the extraction of gold from its ores, has, we understand, compromised with the South African miners and reduced its terms. Better half a royalty than no royalty at all. But for the greediness of the Cassel Company, it is probable that the monopoly of the cyanide would never have been attacked.

We are told that other lawsuits will take place shortly in Germany and America, where the validity of the cyanide patents is also disputed.

ELECTRIC BRAKES.

A recent number of the *Electrical World* (New York) describes a form of brake that appears to have some points of novelty and interest. This is known as Sperry's, and was recently described by the inventor in a paper before the American Institute of Electrical Engineers. It is stated that 85 per cent. of electric tramway accidents arise from lack of brake power. At 10 miles per hour a car can be stopped by a wheel brake in 10 feet, but by hand power a retarding effort of only 400 pounds can be secured. This is less than one-third what is possible if power is available.

In the Sperry electrical brake, the apparatus consists essentially of a strong solid ring of iron, energised by containing within concentric grooves coils of wire which receive current. A gap in the ring converts it into a circular form of magnet. One side of the ring is capable of being brought into contact with the faced side of one of the car wheels. When current is shut off the motor of the car, the same lever places the motor terminals in connection with the coils of the brake magnet. The motor now acts as a dynamo, and thus far absorbs some of the energy of the moving car. The current energises the magnet, which is thereby made to attract the wheel, and a powerful double retarding effect is produced, which is greatest, of course, at the highest speed, and ceases shortly after the car stops, the residual effect of the high inductance of the braking circuit usually being enough to hold the car on even heavy grades, while a passenger alights, without calling for the use of the hand brake.

The wheel, also, is claimed to act as a magneto-dynamo armature in generating powerful eddy currents, thus creating a powerful retarding effort.

One handle controls the car. To stop the car, it is moved to the right. This turns off the station current and converts the motor into a low speed dynamo. The brakes are then applied by moving the lever back to the left again, the greatest amount of movement giving the highest effect. The same rheostat serves for this as serves for the car regulation.

The act of releasing the brake, again establishes the trolley contact, and reconverts the brake dynamo to a motor, and so on, the manipulation being simple.

The circular magnet surrounds the axle of the car and is carried by the framing, but is free to swing laterally against the wheel, from which, however, when demagnetised, it falls away by gravity, its suspension link being a little off the vertical. In the gap of the magnet is a carbon brush which lubricates the brake surfaces and improves the effect by the improvement in the circulation of the eddy current, which is brought about by the graphite between the two surfaces.

It is claimed to be powerful, certain, and effective, cheap to operate, because it uses no trolley current. There is a saving in wheels, an entire absence of shoes, absolute quiet, and smooth action, no strain on the motor man, and no flat wheels, whereby we are to understand that it is easy to so regulate it that the wheel never skids. Of course, if the wheel began to skid, there would cease to be a braking current, and the wheel would again revolve. Thus the device becomes very largely self adjusting.

THEORY AND PRACTICE IN ELECTRICAL ENGINEERING.

By RANKIN KENNEDY.

The nearer theory and practice approach, the better in any science or art. Wherever we find practice widely different from what theory indicates, we may be sure that one or other is somewhere wrong, and it is sometimes profitable and always interesting to compare practice with theory, and thereby ascertain just where we are in these matters.

Hitherto practice has been somewhat unsettled in electrical engineering, but the completion of many public supply stations, and the operation of some of them for a year or two, offers sufficient experience to enable us to compare theory with practice on most important points in electrical engineering.

We will first glance at electrical distribution of energy. The distribution of electrical energy may be carried out by either continuous currents or by alternating currents, and either by high pressure and transformers, or by low pressure without transformers, on either system.

The simplest system is the low pressure two-wire continuous, or alternating current at 110 volts. Theory and practice agree in this case closely; theory proves that an enormous amount of copper is required in the mains to prevent serious loss of pressure and bad regulation, and practice confirms it.

As an improvement on this simple system, theory introduced the three-wire and five-wire systems for the purpose of saving copper in the mains, and thereby also improving the regulation.

Prior to this three-wire system, there was commonly known to practice a three and five-wire system, called the multiple series system, for the same purposes, but the balancing wires were not connected back to the dynamos. Theory pointed out that the balancing wires must go back to the junction of the dynamos, and that then each multiple would be independent of the other multiples, and the theory being very plausible, it was accepted by practice, and in we went for it plump. But practice has shown that the theory does not come out all right. In fact, that there is not much superiority in the three-wire system over the older multiple series system; indeed, the balancing wire going back to the

dynamo makes but a small improvement. Yet according to theory this wire should take care of the balancing, whatever the difference between the loads on the two arms of the system. But what does practice disclose? This: that at times of small load, 20, 30, or 50 ampères thrown on one arm of a three-wire system disturbs the whole so much that regulations are made by the managers forbidding the sudden switching on of currents of this small magnitude. With such regulations the old multiple series system would work almost as well, and secure every advantage of the three and five-wire systems.

The disturbances on the three-wire system are most at small loads, it is said; but if theory is right, there should be no disturbance at all. The disturbance is also greatest at light loads with multiple series systems, and is very little, if any, at heavy loads in a properly wired system, so that, practically, we find that the three-wire and five-wire systems are not much improvement on the old multiple series systems, for with the same strict precautions as are applied to the three and five-wire systems, a three or five-wire multiple series system would do quite as well. There is, however, no harm in bringing back the balancing wires to the dynamo junctions; they do exercise a little regulation certainly, and every little is worth securing, but they do not effect their purpose completely—that is, to balance the load—for if the load in one circuit suddenly varies, the balance is at once disturbed, and we have fluctuations in pressure ranging from 3 to 10 volts, hence the tender regard for motors and arc lamps on a three-wire system.

Storage batteries may now be compared from the same points of theory and practice.

Theoretically, the storage battery was to act as a sort of fly-wheel, and regulate for variations in load. When it is used for this purpose, however, it is found in practice that they do not act as regulators automatically; certainly, if the pressure falls they feed into the mains, and if the pressure rises on the mains they take up energy, but they do not prevent a rise and fall; in fact, they do not act at all if the pressure is steady, the pressure must fall *before* they feed in, and must rise again *before* they charge up.

Practically, storage is used at most stations only to meet the small demand for current during the day or small hours in the morning, a demand which would be better met by a small gas engine or two and a couple of dynamos.

Theoretically, the storage battery was to perform wonders. Practically, it does not answer, for one grand reason, it cannot be charged and be discharging at the same time, like a water, compressed air, or gas reservoir; their only value at present is to provide against a breakdown in machinery.

Now, why should there be two kinds of current used, continuous and alternating? Theory answers by stating that if electrical energy is to be transmitted any great distance and in considerable quantity, high pressure must be used; and as alternating currents are easily transformed, alternating currents are therefore adopted. Quite so: here theory is correct, and practice agrees in every way; but what do we *find* in actual practice?

Bearing in mind the sole reason for using alternating currents is the necessity for transmitting large quantities of electrical energy over long distances, so that high pressure may be used and copper saved, that is the theory. What do we find in practice? Corporations and towns laying down high pressure alternating systems where the conditions stated do not exist, where no great quantity of electrical energy is to be transmitted to any distance worth considering, and using 2,000 volts alternating to transmit 50 or so horse-power round a corner into the next street. This practice is absurd. The high pressure dynamos, mains, and transformers, are entirely out of place, and quite superfluous. The small quantity of copper saved in the feeders is far overbalanced by the cost of transformers and other appliances required in connection with high pressure.

In some cases the conditions where high pressure effects a saving do exist, such as where the power house is some miles distant from the centres to be fed and the centres are wide apart, like the Deptford and Niagara schemes; in these cases theory and practice are in perfect accord, but the lighting of the City of London, of Hampstead, Derby, Portsmouth, Scarborough, &c., by alternating currents is bad practice, and contrary to theory, and neither by scientific argument nor by results can the adoption of alternating systems in these and many other places be justified.

Before passing from alternating current systems, let us look at the question of parallel running of the generators, where alternators are necessary. This practice is good, and in perfect accord with theory, provided certain precautions are taken; chief among which is the provision of an automatic instantaneously acting cut-out, placed to cut off any alternator falling out of step or breaking down; with this provided, no falling out of step or accident to one alternator can interfere with the continuance of the lighting. But if separate alternators are used for separate circuits, with no alternators in parallel, as is said to be the case in some places, then, in the event of a breakdown or accident, or the exciting current failing, instant failure of the lighting is inevitable; to abandon parallel running is, both in theory and practice, a mistake; having no storage to fall back upon, parallel running is absolutely necessary. If alternators are run separately, duplicate machines must be provided and kept going, ready to switch in at any moment, but even then there would be an interruption of the lighting.

Thus we see that in some cases theory falls short; in others practice is at fault.

Recently I pointed out the difference between theory and practice in using choking coils; theoretically these coils save energy, but practically the user has to pay all the same for the energy saved, if he is supplied by a public supply through an ordinary meter.

Theoretically the alternating current has advantages for the electrical engineer in transmitting his electrical energy, but practically, to the man who pays for electrical energy, alternating currents have many serious drawbacks, and the practical question is whether the engineer's conveniences, or the consumer's needs, are to be paramount.

Only for one purpose are both currents equally good, and that is for incandescent lamps. For all other purposes the continuous current is preferable by the consumer, both theoretically and practically.

Theoretically, the current is generated and distributed, to be sold to consumers for application to any purpose; but practically, except for incandescent lighting, it is too costly, hence it is almost exclusively used for incandescent lamps, and the would-be consumer for other purposes is not worth considering.

These few points of agreement and divergencies between theory and practice have struck me as important and well worth attention. They are not pointed out in any fault-finding spirit, but as interesting facts for those looking for guidance in the choice of methods and practice.

Theoretically, alternators have no commutators; but as an exciter is a necessary attendant upon the alternator, practically the commutator is all there, and is of as great importance as ever, for a slight derangement of the exciting circuit will throw most alternators out of step.

Finally, the disadvantages of alternating currents have been practically ten-fold multiplied by the insane practice of adopting various frequencies, instead of fixing upon one common frequency. There is no known theory to account for one place working at 50, another at 100, and another at 133 per second.

EXPERIMENTS IN THE UTILISATION OF CHEMICAL ENERGY FOR THE PRODUCTION OF ELECTRICITY.

In a paper read before the *Deutsche Electrochemische Gesellschaft* last month, Dr. W. Borchers describes some interesting experiments he has been making on the direct production of electricity from coal and combustible gases.

His first experiments were made with carbonic oxide gas, but he also succeeded in producing an electric current by the combustion of hydrogen, hydro-carbon gases, and even from pulverised coal. His great invention, however, is the use of cuprous chloride as the electrolyte in his battery. It is well known that cuprous chloride is a good absorbent for both carbonic oxide and oxygen. It appears natural, therefore, to suppose that it will form a suitable electrolyte to promote chemical combination in a gas battery, with carbonic oxide and oxygen as its elements.

The first apparatus was made of any glass or stoneware vessel

to hand, which could conveniently be divided into two compartments, communicating at the bottom. The vessel was partly filled with an ammoniacal or acid solution of cuprous chloride, air was supplied to one compartment and carbonic oxide to the other. When the carbon poles, with which the compartments were furnished, were connected, a weak electric current was obtained. By placing pieces of coke in the cells and thus increasing the surface of contact between the gas and the liquid, a considerable increase in the strength of

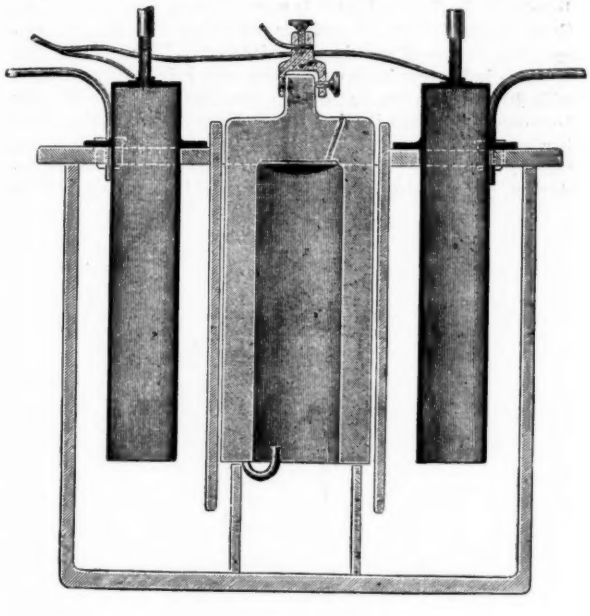


Fig. 1.

the current was obtained. The results of this first experiment, if not exactly discouraging, were far from being up to expectation. Platinum poles would probably have given a better effect than carbon, but the use of this metal was forbidden by its price. It then occurred to the author that copper might be safely used as a pole in the carbonic oxide cell, the probability being that it would not be dissolved, since carbonic oxide precipitates copper from cuprous salts. This supposition was found by experiment to be correct, and it thus became practicable to make the vessel containing the electrolyte of copper, and to connect to it one of the terminals of the external circuit.

The preliminary apparatus by which these points were established is shown in fig. 1. A glass vessel was divided into three compartments by two glass plates which did not reach quite to the bottom. In both the exterior compartments copper tubes were suspended for the introduction of the carbonic oxide gas. In the middle compartment, a carbon bell dipped, for the introduction of air. A solution of cuprous chloride was used as the electrolyte. The copper tubes were weighed. The carbonic oxide cells were protected against the entrance of air by lids. The carbonic oxide, which was used in the first experiments, was afterwards, for convenience, replaced by coal gas, which contained at least 5 per cent. of the former. No decrease in the weight of the copper was at any time ascertained; on the contrary on one occasion a slight increase was observed.

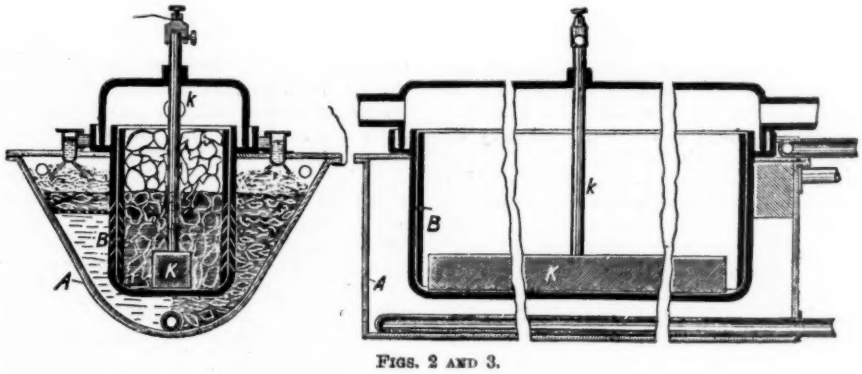
Acid solutions of cuprous chloride gave better results than alkaline solutions. Table I. gives the results of measurements made when carbonic oxide strongly contaminated with carbonic acid, an acid solution of cuprous chloride, and air, were used in the battery.

Table I.

External resistance in ohms.	E.M.F. in volts.	Current strength in ampères.
0·1	0·05	0·5
1	0·20	0·20
2	0·23	0·13
3	0·25	0·10
4	0·275	0·075
5	...	0·060
7	...	0·050
10	0·300	0·040
15	...	0·028
20	0·400	0·020
25	...	0·015
30	...	0·012
40	...	0·010
50	0·400	0·008

To facilitate the absorption of carbonic oxide by exposing a greater surface of contact the external cells were filled with copper clippings. By using at the same time a gas corresponding in composition to generator gas, a current of as much as 0·64 ampère was obtained on short circuit, while by gradually increasing the external resistance a maximum value for the E.M.F. of 0·56 volt was reached.

This result, to be sure, is not to be characterised as in every respect favourable, since the E.M.F. calculated from the chemical combination of carbonic oxide and oxygen alone is 1·47 volts. From the results of the experiments given above as compared with the maximum theoretical voltage, at least 27 per cent. of the energy of the fuel is converted into electricity. By the use of a gas among whose combustible constituents are, besides carbonic oxide, hydrogen and hydrocarbons, the effect appears to be still more favourable. According as the lowest or the highest values of these combustibles are taken, the electric energy produced is 38 per cent., or 26 per cent. of the energy of chemical combination. If, therefore, in a comparatively incomplete apparatus one-quarter to one-third of the chemical energy of the fuel can be converted into electricity, this success may well give encouragement to further efforts.



Figs. 2 and 3.

It is well-known that a solution of cuprous chloride also dissolves hydro-carbons. It may not therefore be necessary to convert the fuel into carbonic oxide. Powdered coal was tried in the above apparatus instead of carbonic oxide, and the strength of current and E.M.F. obtained were not far behind those obtained with gaseous fuel. A maximum E.M.F. of 0·3 volts, and a maximum current of 0·4 ampères was obtained.

The oxidation of carbon corresponds to a theoretical voltage of 2 volts; thus 0·3 volt corresponds to an efficiency of

15 per cent. Even with considerable motion in the liquid a falling off in the current soon takes place with coal dust, and this has never been observed with the use of carbonic oxide, or coal gas. The gradual pollution of the liquid with the use of coal would forbid its use even with a more favourable efficiency. The author considers that the use of the gas element is the only way by which success is likely to be attained.

The most recent design of the gaseous fuel element elaborated by the author after the trial of many forms is shown in figs. 2 and 3. The external vessel, A, is of copper and contains the cuprous chloride electrolyte. The inner vessel, B, is of earthenware with double sides which are perforated, and contains the space for the cathode. The space between the double sides may be filled with a porous material if necessary. The vessel, A, is furnished with a lid having two holes for the inlet and outlet of the gas, and an aperture in the centre through which a carbon rod, *k*, passes down to the carbon plate, K. The space above the carbon plate may be filled with broken coke to increase the surface of contact. For the same reason, the outer vessel is filled with clippings of copper. The cuprous chloride is supplied by channels running along the lid of the external vessel, A, and drawn off by a pipe at the bottom of the vessel. The gas and the electrolyte can thus be circulated through a series of cells in a large battery. Pipes are also fitted to circulate air in the upper part of the copper vessel. The author also describes a form of cell adapted for the combustion of powdered coal. The latest form of the gas element described above has not yet been tested, being still in the course of construction.

THE NATIONAL TELEPHONE COMPANY'S NEW EXCHANGE.

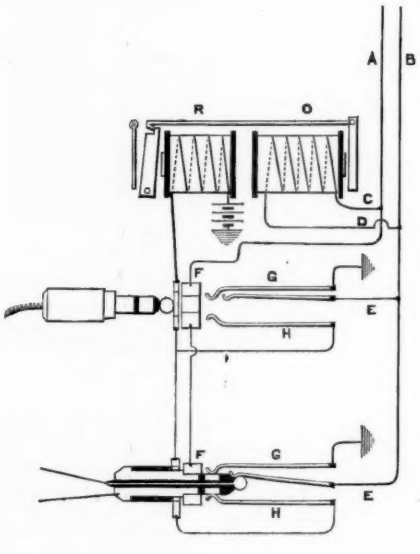
On Monday last the principal City Exchange of the National Telephone Company, situated in Lime Street, was thrown open to the representatives of the Press. In the new arrangements have been embodied the latest improvements in telephonic engineering. America, as we know, has always been to the fore in telephonic work, and it is, perhaps, in this branch of the electro-technical industry more than any other, always excepting the overhead wires, that we can follow the practice of the States with advantage to ourselves; and the appointments of the new exchange are not only a credit to the manufacturers, but also indicative that the directors of the company are fully alive to the necessity of securing the very best articles in the market.

An iron derrick has been constructed on the roof, to which are attached the wires coming from the subscribers' offices, and the junction wires from other London exchanges. This is constructed of 39 tubular iron poles, forming an octagonal structure, the poles being braced together with iron arms, and securely fastened to the outside walls by iron rope stays. The circumference of the derrick is 190 feet, and is capable of carrying 6,000 wires; besides this, provision has been made for leading in a considerable number of wires in cables, each cable containing 104 wires, equal to 52 subscribers. From the derrick the wires are led by means of cables into the test room, and are there attached to brass springs arranged in numerical order corresponding with the subscribers' numbers. It is here that the subscribers' lines are tested for faults, and the faults localised.

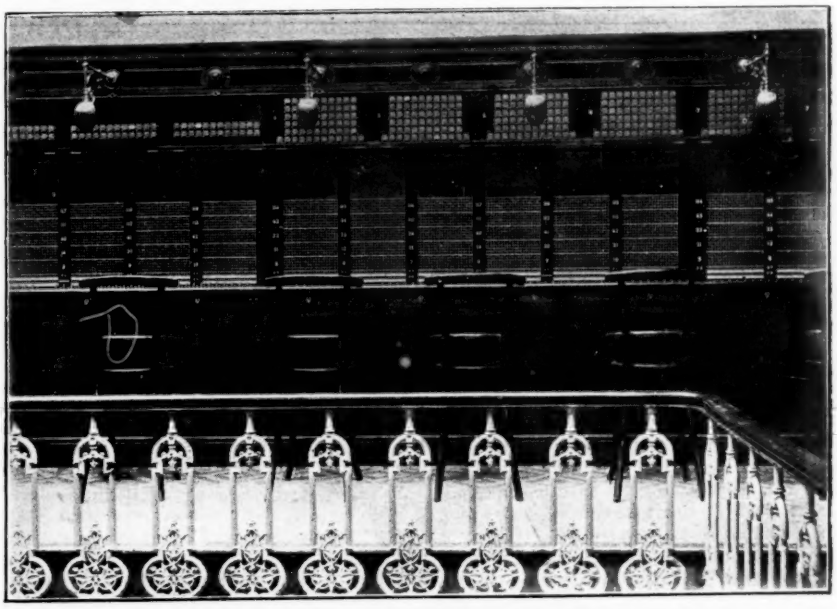
We believe that the whole of this stupendous structure, which must be seen before the arduous labour and more than ordinary skill attached to its design and construction can be perfectly realised, is due to Mr. Alfred Perkins, a gentleman for many years known to us as having had exceptional experience in overhead work, and we are pleased to publicly put on record an achievement which would do credit to any engineer.

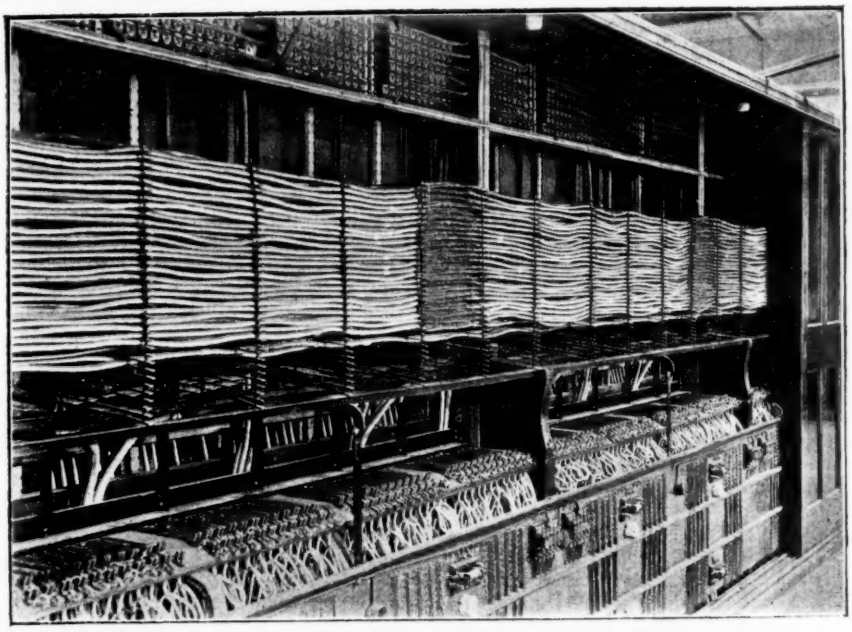
From the test room the wires are led in a lighter class of cable into the switch room, which has given Mr. Phillips and his assistant, Mr. Cook, an opportunity of showing their powers of organisation, combined with a perfect mastery of the intricate details of telephonic business.

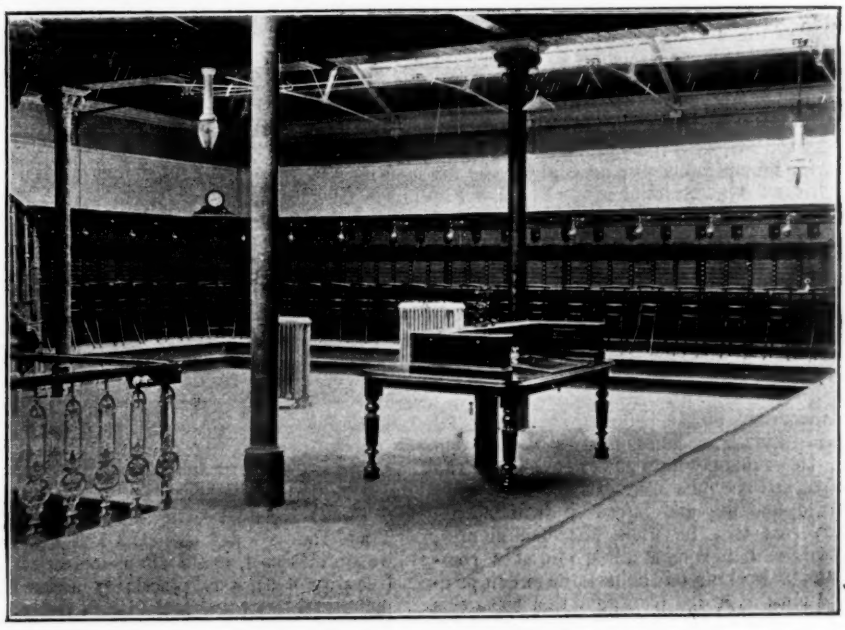
The switchboard is one of the latest designs of the Western Electric Company, known as the branching system. To anyone familiar only with the older kinds of multiple boards, the first impression of the Lime Street Exchange is one of surprise at noticing that the indicators and the spring jacks have changed their usual positions on the boards. Instead of being below the jacks, immediately in front of and within easy reach of the operator, the indicators are above the jacks, and out of the operator's reach. The reason of this becomes plain when watching the process of putting through a call. The operator inserts a plug in the required jack, and immediately the indicator shutter is restored to its normal position. Even to one thoroughly familiar with electrical devices, the operation is one of considerable interest. There are 3,000 of these indicators in the exchange, each being in connection with 20 spring-jacks, and on the insertion of a plug in any jack connected with its line, the indicator of a calling line is restored, and prevented from falling until the line is again free; the indicator of a called line which does not need restoring, does, however, need locking, and this purpose is also



served by inserting the second plug in the jack of a subscriber called. Promptly, silently, and with unerring accuracy the opening shutter becomes closed, the unopened shutter is firmly locked, so to remain until the removal of the plugs leaves them again free to transmit the calling signal when required. With these switchboards, therefore, the operator is saved the expenditure of time and attention occupied in resetting an indicator, and there is an absence of the usual clicking of the shutters and detents. There is the additional advantage that there is no uncertainty about the relationship of jack and indicator. The resetting of the shutter is a convincing proof that the operator is in communication with the subscriber who has called. Ingenious as is the indicator, no less so is the spring jack. It is so devised that there is no make-and-break contact in it. The two wires of a subscribers' circuit go right through the boards unbroken; branches are taken from those lines for each jack, one branch to a short spring, the other branch to the bush of the jack. Two springs of equal length (but longer than the line spring), and a testing point, complete the spring jack; these latter being in connection with the local circuit through whose instrumentality the operator learns whether a line is engaged and the indicator is restored. So far as the act of testing is concerned, it is the same in these as in other multiple boards —the touching of a called jack by one of the connecting plugs; but as the switchboard is for metallic circuit working, the test circuit, instead of being connected to the line, reverts to a still earlier form, and is entirely distinct from the line circuit. The reason for giving the jack its peculiar construction only becomes apparent on inspecting the plug. In form the plug is the same as its predecessors, with a tip, a shank, and a handle. The tip is insulated from the shank, and is connected with one of the conductors of the cord; the shank is divided into two parts, of which one is connected with the second conductor of the cord.







The upper part of the shank is simply a metallic ring insulated from the lower part and from the tip. It becomes thus easy to see why the pair of springs connected with the test circuit are equal in length and longer than the line spring. The tip of the plug makes one line contact, the shank of the plug the other line contact, the metallic ring between them puts the two test springs in contact, and completes the local circuit which has hitherto been broken. It will thus be seen that neither in the line circuit nor the test circuit are there any makes and breaks in the jack contacts.

The clearing-out indicator is also self-restoring, and is bridged across the line between the pair of connecting plugs. It is restored after falling by the operation of the keys. There are thus two subscribers' drops and one clearing-out drop bridged across a connecting line, and the operating coils are consequently wound to a high resistance, and are covered with shields specially designed to produce great impedance to the passage of telephonic currents in order that, if we may so express it, the impedance of any practicable number of bridges forms no impediment to the passage of the telephonic current along the main line.

The operation of the keyboard apparatus is similar to previous boards, though the design of the material is necessarily modified to the changed circuits, but we cannot attempt to describe these changes in detail within the space now at our disposal. The keyboard differs from previous construction in being inclined at an angle sloping downwards from front to back.

The illustrations show one section complete, with portions of its neighbours on either side, a back view of the switchboards, showing the cables through which all connections are carried to the jacks, &c., and a partial view of the room.

The diagram shows one subscribers' indicator, and two of the spring jacks pertaining to the same line with the plugs, by means of which connections are made. A and B are the two lines forming a metallic circuit, C and D are the branches from the lines to the operating coil, O, of the indicator, E the branch to the line spring of the jack, F is the other line contact on the bush of the jack, G, H are the springs connected to the local circuit, R is the restoring coil; one plug is shown in section as connected to the jack, the other plug is as used in the act of resting.

At present the switchboard is fitted for 3,000 subscribers, besides the necessary wires giving connections to other exchanges of the company, both in London and other important towns in the country, viz., Liverpool, Manchester, Leeds, Birmingham, &c.

The switchboard is divided into 20½ sections, every wire coming into the exchange being led on to the first section, and thence to the second, third, and every other section in the room, which means that each of the 3,000 subscribers' wires is attached to a separate spring jack on each section throughout the room. This, together with the necessary junction wires, involves the use of 73,540 "spring jacks," and as each "spring jack" requires five wires to be soldered to it, there are in all, including the soldered connections to the indicators, over 500,000 soldered joints in the room, and the length of wire is over 800 miles.

On the floor under the switchroom is provided a dining-room, kitchen, &c., for the operators, also an engine-room for the engine, which drives a dynamo for charging the electrical accumulators with the necessary currents for the working of the exchange.

The whole of the arrangement of the exchange, including the subscribers' wires and instruments, has been designed and carried out to work on the complete metallic circuit or "double wire system," this system being the most approved and yielding the best results in a case like London where the difficulties connected with technical details are of a complex character.

The metropolitan system of the company consists of 30 exchanges, all joined together by junction wires to form one whole. Of these, 10 exchanges are now working on the double wire principle, and the remaining exchanges are being actively reconstructed, and new and improved switchboards provided. It is expected that the whole Metropolitan area, which covers upwards of 600 square miles, will, at a comparatively early date, be working on the metallic circuit principle, with new and most approved plant, and that when this work is completed London will be provided with a telephone system equal, if not superior, to that of any great city in the world. The cost to the company of this great work will probably be not far short of £200,000.

We wish to acknowledge the courtesy of Mr. Calder, the metropolitan manager, and the lucid explanations of Mr. Cook, which ought to have kept even the "lady journalist" from going astray, but they didn't.

The directors and Mr. Dane Sinclair, the engineer-in-chief, are to be congratulated on the efforts they are making to give the Metropolis extra telephonic facilities, and in having such an efficient and highly trained technical staff to aid them.

DOMESTIC ELECTRIC LIGHTING PLANTS.

Under this heading, in the *Engineering Magazine*, Mr. Nelson W. Perry discusses the question of domestic lighting by private installations, in which respects he considers England and Germany are far ahead of the United States. It is, he says, from these two countries that Americans have learned that more light can be obtained by using gas in an engine to drive a dynamo than can be produced by burning the gas in the best burners. This he sets out to prove, and quotes Tyndall to the effect that the average luminous radiations of the gas flame are but ·00317 of the total radiations. Now, in the incandescent electric light a 3·5 watt lamp has an efficiency of ·06, or 18-fold that of the gas flame. The gas engine thermal efficiency may be 20 per cent., and its mechanical efficiency 85 per cent., with a 95 per cent. dynamo efficiency. Multiplying the efficiencies, we get a final of 1 per cent. of the gas energy reproduced as light in the filament, but other losses, as belt transmission and current transmission losses, reduce the efficiency to ·00816, as against ·00317, or the ratio is 2·57 to 1. The U.S. Consul in Germany reported last spring that there were in use in manufactories not requiring more than 75 to 150 H.P., no fewer than 18,000 gas motors of 60,000 aggregate H.P., and that there must be in use altogether 24,000 or 25,000 gas engines, two principal makers having made 1,950 in the previous two years. In England there are some 40,000 in use, of which 12½ per cent. are producing electric light. Statistics are wanting as to the number in America, but it is smaller, and the proportion driving electrical machinery quite insignificant. A table of engine results is given, from which it is concluded that one 16 C.P. lamp-hour costs a minimum of $\frac{3}{16}$ths cent for full load, and about 3½ tenths when the load is light. Assuming 5 cubic feet for the same effect, gas would cost 7½ tenths of a cent. In each case gas is assumed to cost $1.50 per 1,000 feet, or about double London price.

Investigating the question of good behaviour of the gas engine, he has opened up a considerable correspondence, and finds in one case a 6 H.P. gas engine and 2½ kw. generator, running from 0 to 12 hours daily, works out to cost ¼ cent per lamp hour, with gas at $1·000 per 1,000 feet. Several others write that the gas engine is satisfactory, and he concludes that though the addition of a storage battery more than doubles the cost of installation, it permits of a smaller plant being used and worked also at maximum, and therefore most effective rates. The trouble, however, in America, has been that there are no firms who undertake the good performance of the plant as a whole.

One company puts in the engine, another the dynamo, and a third the storage battery, and evidently do not pull together, and so a most promising field of work has been neglected for want of a sufficient enterprise or faith to assume the whole risk. We think there are no electrical firms in England who would not guarantee the whole performance of a plant, if free to order such gas engine and appliances as they thought fit.

Those Meters!—The last state of the Manchester Free Trade Hall is worse than the first. The Thomson meters, we are informed, in the discussion on Mr. Henderson's paper (see page 639), were practically useless; but the five-wire meter registers whether the lamps are being used or not. It has evidently been demoralised by a neighbouring gas meter.

CORRESPONDENCE.

Expert Evidence.

The recent "cyanide process" reminds the readers too painfully of Palmer's case, and of the "Torbane Hill" trial, and fully warrants your comments. It seems to me that our present method of obtaining and dealing with scientific and technical evidence is fundamentally wrong. The expert—be he chemist, electrician, microscopist, engineer, or what not—should not be "called" by either of the litigants, and consequently be treated as a partisan. His proper position should be that of assessor to the Court. The system of conveying the needful information to judge and jury, *à la* Pinnock's Catechism, by question and answer, is in itself unhappy. It is doubtless sufficient for trials for burglary, manslaughter, &c., but for questions of public health, poisoning, inventions, &c., it is as well adapted as would be a coal shovel for performing a microscopic dissection. A certain judge declared a few years ago that if experts were only determined to tell simply the truth, "bullying, and all that sort of thing," would never occur. He forgot that when the plain truth would be injurious to their clients, counsel endeavour to prevent it from being told, and thanks to the license allowed them, they find here no difficulty.

At present it is very difficult for an expert to enter the witness-box without receiving insults, for which neither the law nor public opinion offers any redress. On the other hand, public opinion allows a barrister to employ the *suppressio veri* and the *suggestio falsi* in defence of the most notorious quack.

J. W. Slater.

Electro-Deposition of Gold.

Having read with much interest Mr. Andreoli's paper on the above subject, I venture a few remarks on it.

It is interesting to note that experiments I have been conducting lately (which were carried out entirely in ignorance of the work being done by Mr. Gernet) agree to a large extent with his.

The first query Mr. Andreoli raises is as to the nature of the ion (incorrectly called "metalloid") liberated at the + pole.

This will apparently vary with the strength of solution, oxygen being liberated with a weak and cyanate with a strong solution; but this apparent difference is easily accounted for by supposing that the oxygen while in a nascent state combines with the KCy when it is in sufficient quantity to form KCy O. The amount of gold which will be deposited in a given time will always vary with the amount of gold in the solution; as the solution gets weaker and weaker, it gets more and more difficult to torture out the gold and to remove the last traces—that is, at a rate of about 1 dwt. per ton of solution—seems to be a matter of such extreme difficulty, that I think it is really better to allow it to remain there and use the solution over again for the purpose of dissolving more gold from the ores. In fact, to always have a small quantity of gold present as an essential part of the working solution. The only objection to this is that the small amount of solution which is unavoidably left in the tailings after the main bulk has been drained off, is thereby lost. Mr. Andreoli goes on to say: "It is not quite clear how circulation can help much, &c.," and then, "In all electrolytic processes circulation is essential."

From this, one would conclude that he does not know why circulation is necessary in any electrolytic process, although he admits it is essential. It is difficult to believe that anyone of Mr. Andreoli's experience should never have questioned this point before, and I would remind him of a very old text-book experiment in which two copper plates are immersed in a solution of copper sulphate.

After a current has passed for a short time, the bath having been kept quite still, it will be seen that the solution near the cathode is lighter in colour owing to the impoverishment of copper from the solution, while that near the anode is darker, owing to the formation of copper sulphate. The object of circulating the solution, therefore, is to keep the strength as uniform as possible. This is all the more important in the case of a weak solution, because the solution immediately surrounding the cathode is sooner impoverished.

In what form is the gold deposited on the cathode? It is often necessary in copper works to have to deposit practically all the copper out of a solution, and when the solution weakens, the deposited copper assumes a spongy form, black and as fine as flour. If the gold were deposited like this, it would soon be washed off the surface, and either lost or redissolved.

The question of anodes is not such an important one as Mr. Andreoli seems to think. Many substances will do for this, notably iron. It is usually supposed that iron anodes used in a cyanide solution form Prussian blue, but it is a simple laboratory experiment to show that this is not the case. If, however, the iron is allowed to oxidise, there is a great liability for Prussian blue to be formed. But what is the objection to carbon anodes? If a good carbon is used the disintegration is very slow in a cyanide solution. Besides, the current density on the anode surface can be a great deal greater than that on the cathode surface. The essential point for the complete deposition of gold from a weak solution is, that the cathode surface should be as great as possible; the anode surface does not matter in the least, so long as it is sufficiently great to keep down the volts at the terminals of the tank to something reasonable. Three or four arc lamp carbons hung in a row and electrically connected would make an excellent anode, and would answer as perfectly as a sheet of carbon, except that perhaps an extra volt would be required on the tank.

The current used, 600 ampères, seems to be singularly high. The chief objection to this is not the cost of producing so much as the large amount of cyanide which such a current would decompose, and it is difficult to believe that the loss is as low as $\frac{1}{4}$ lb. per ton of ore treated, unless this constitutes all the cyanide in the solution. Mr. Gernet says: "A better effect is obtained by doubling the plates, than by increasing the current ten-fold." Why not double the number of plates and so reduce this large current to 60 ampères, and thus reduce the loss of cyanide, besides saving loss by the wear and tear of the anodes.

According to Mr. Gernet's own statement, the deposition of the gold would be equally efficient. I agree with Mr. Andreoli that we ought to have some information as regards the yield of gold from the solution. This, which is the all important point, the point on which the whole question of the practicability of the process is pivoted, is avoided. Mr. Gernet does not surely mean to assume that all the gold is deposited out, although provided that the solution is used over again, a small quantity left in the solution would not matter much.

The question of being able to completely deposit a metal from its solution raises a very important point, and one which when solved, will have many practical applications. I should very much like to see Mr. Andreoli, or some other practical electro-chemist, coming forward with some definite experimental result on this subject.

Alf. T. Weightman.

Cyanide and Electrolytic Cyanide Solutions.

I beg leave to respectfully inform you that the statement in the first paragraph on page 588 of your ELECTRICAL REVIEW of November 16th, 1894, that I "affirmed in a most solemn manner that it was not previously known that gold was dissolved in cyanide of potassium" is entirely untrue.

G. Gore.

[From Dr. Gore's communication it seems that Mr. Andreoli has misread the evidence in the Cassel case.—EDS. ELEC. REV.]

Central Station Book-keeping.

I have noticed in your issue of October 26th a very flattering review of my little book on "Central Station Book-keeping." Kindly accept my thanks for the same.

To one point that you mention I desire to call your attention, as it is purely a difference in method obtaining between the two countries. In the third paragraph of your review you call attention to the fact that the forms of books suggested include engineering detail as well as cash transactions, and you seem to question whether such a method can be successfully carried out.

Your point is quite well taken, and had we a Board of Trade by whom the accounts could be regulated, there is not the least doubt in my mind that such an obvious simplification as you suggest could be made.

While it is a debatable question if we should have so many electric lighting companies if we did have a Board of Trade, I must say that the method of accounting I have shown, *i.e.*, the keeping of all data affecting the customer, on the customer's ledger, is very extensively in use, has proved quite successful, and actually saves time, in the business as conducted in *this country*.

I am, indeed, glad to have these points brought out, and should always esteem criticisms of great value when coming from journals of the character of the REVIEW.

Again, gentlemen, allow me to thank you for your very kind notice.

Horatio A. Foster.

Office of the Electrical Consulting Engineer,
Cataract Construction Company, New York.

A Dry Pocket Accumulator.

I send you the account of experiments made in my laboratory by my assistant, who has a very extended experience of various primary and secondary cells, and another young electrical student. The results recorded are, I think, of some interest; in the first place, because a dry pocket battery is not, like all the "wet" ones I have known, an appliance destructive to clothes, &c.; secondly, because it has been assumed that, by reason of the non-circulation of the electrolyte and the resistance offered by an absorbent, a *dry* pocket cell to work a small lamp, &c., is practically an impossibility; and, thirdly, because the results in question indicate the possibility of great improvement in the construction of accumulators for traction and other purposes. In little more than a month, many thousands of pocket and portable accumulators will be in use for spectacular and scenic display; and it is to be regretted that something more effective and less destructive than these appliances as hitherto made has not already been introduced. I will send for your inspection, and for any test you may wish to apply to it, the little battery that was the subject of these experiments.

Desmond G. FitzGerald.

Experiments with one of FitzGerald's solid two-cell pocket accumulators (numbered 14).

Dimensions:—4 inches by 3 inches by 1 inch.

Weight:—1 lb. 2 ozs. (under).

The discharge was commenced immediately on disconnecting the battery from the charging source. The battery was circuited through an Ayrton & Perry spring ammeter, reading from 3 to 20 ampères, and the primary of an induction coil. The following results were obtained:—

Time (in seconds).	Current (in ampères).
0	12·9
15	12·5
30	12·0
45	11·3
60	10·6
75	9·9

This experiment was tried to ascertain what was practically the maximum current obtainable, and whether this current would injure the battery. The contact-breaker was now started, and the battery was set to work the coil through the ammeter, the secondary being connected to a small Andreoli's ozoniser. The mean current as indicated by the ammeter from time to time during the discharge is given below:—

Time (in seconds).	Current (in ampères).
0	4
30	3·5
45	3·4
60	3·5
Time (in minutes).	**Current (ampères).**
1·5	3·5
2·0	3·3
2·5	3·25
3·0	3·1
3·5	3·1
4·0	3·0
4·5	3·0
5·0	2·8

The current having fallen below 3 ampères, the discharge was then stopped.

After these heavy discharges, the battery lit a small 4-volt lamp (taking a current of about one-third ampère) for 45 minutes; at the end of this time the lamp was still quite bright, but the experiment was discontinued for half an hour, after which the lamp was lit for 30 minutes more, when it began to grow dim; the circuit was accordingly opened. Instead of recovering itself, the battery, after a rest, was found incapable of lighting the lamp. For this and other reasons, we believe that there was internal leakage between the elements. Nevertheless, we think that these results, more especially in the case of a so-called "dry" cell, are remarkable, and probably unprecedented.

G. C. ALLINGHAM.
E. A. ISON.

November 17th, 1894.

Designing of Large Alternators.

He must be indeed a sorry sportsman to whom the flying of the feathers brings no sense of invigoration. When I wrote you on the 9th inst. mildly expressing my indignation, not at Mr. Armstrong's opinions on the subject of alternators but at the quality of the logic which he thought fit to serve up for the edification of the Britisher, I had no expectation that in aiming at the sparrow I should bring down a kite.

It is under these circumstances that I have received the distinguished honour of being called a liar by your legal correspondent of the 16th inst.

My reasons for considering myself honoured by Mr. Kite's verdict will soon be apparent, for the same letter which impugns my veracity contains a sample of the article which the author, with due consideration and in the light of his legal responsibility, hangs out of his shop door under the label, "This is truth."

Mr. Kite says: "The statement that these two alternators were built to a strict English specification, which was modified at their request to meet the possibilities of their construction, but even with the specification so modified, the said alternators do not even approximately comply, notwithstanding that months have been spent in trying to improve them," is absolutely false.

There is no beating about the bush; he does not say the statement is scarcely true or only partially true, or greatly exaggerated, but he says most distinctly it is *absolutely false*.

The sentence quoted from my letter contains three statements:—

1. The specification was modified to suit their construction.

2. The alternators did not and do not comply with the said specification.

3. Months have been spent in trying to make them comply with the specification.

Which of the above statements has drawn Mr. Kite's feathers? Certainly not the first; there is no sting in it. It is an everyday occurrence for a specification to be modified to suit manufacturers' patterns. The third is equally unimportant, as it depends entirely on the second. If the alternators did and do comply with the specification, of course no one need to improve them. We come, then, to this conclusion, that the second statement is the cause of Mr. Kite's indignation; if this had been omitted, he would have swallowed the other two smilingly.

For his own sake it is a pity that Mr. Kite did not stop at the point where he gives me the lie direct, his letter would have carried just as much conviction as his signature is good for; but, unfortunately for him, he goes on in the next paragraph to justify his position in detail.

He says: "The alternators have been running a year without trouble"—excellent, but irrelevant. Then he says: "Nor have they been altered in the slightest detail." Of course not, if they comply with the specification no one would think of such a thing.

It is superfluous to deny alteration, when the absurdity of any such course could have been demonstrated by these seven words: "The alternators do comply with the specification."

Anyone with half an eye can see that if Mr. Kite had been able to say these seven words, he would not have filled seven lines with totally irrelevant matter.

We come, then, to this simple conclusion: that Mr. Kite's objection to my statement is based entirely upon some mental or verbal quibble as to the exact application, or want of application, of the words: "Notwithstanding that months have been spent in trying to improve them," which words are, in any case, quite unimportant, and do not in the slightest degree affect the validity of my argument that Mr. Armstrong's claim to superior knowledge as to the ways of alternators is an empty boast. All the same, Mr. Kite declares that my statement is absolutely false.

Your readers will now understand why I consider it a distinguished honour to be called a liar by Mr. Kite.

J. S. Raworth.

P.S.—As Mr. Kite has expressed to me his intention of commencing an action against me for libel, and as that is exactly the course which I fear he will not take, I now reiterate my three statements:—

1. The specification was modified at their request to meet the possibilities of their construction.
2. The alternators do not even approximately comply with the specification.
3. Months have been spent in trying to improve them. The word "trying" refers entirely to mental effort.

J. S. R.

Wanted a Conversion Table.

Would you oblige me by telling me where I can procure a really complete table giving the comparative values of B.W.G. to millimetres? Munro and Jamieson don't give the smaller sizes of millimetres in their tables. Thanking you in anticipation,

M. Salmony.

[Perhaps some of our readers will oblige by giving the required information.—Eds. Elec. Rev.]

The Electric Lighting of Donnybrook Fair.

In your last issue you printed a Note headed "Cork," which I hasten to correct in the interest of fair play.

The Donnybrook Fair was open from the 30th ult. to the 6th inst., but at no time throughout the seven days was the electric light in any sense a success. The glow lamps not being fully incandesced; only two arcs were at any time alight, and these burned badly.

As the trial of the electric light on Monday, the 29th ult., proved a failure, the Committee of the Fair had the whole place lit with gas and oil lamps, which were used the whole seven days.

I think the paragraph very unfair to the other firms who tendered for the work, The paragraph, too, bears internal evidence of its doubtful character, as the engine power quoted is not sufficient for the electrical output contracted for.

To whatever cause the fiasco was due, or whatever explanation may be forthcoming, it was so complete as to prejudice many firms here against the electric light. The concluding sentence of your note, "was admitted on all sides to have been far ahead of any temporary installation yet seen in the Emerald Isle, the light being as steady as if run from a central station," is utterly wrong in view of the "Araby Fête" and several *conversaziones* and costume concerts held in the School of Art and elsewhere. The bad foundation could not be an excuse, as a merry-go-round proprietor alongside had his six Brockie-Pell lamps running beautifully, and he does not claim to be an electrical engineer.

That the Electrical Installation Company were able to run at all was due to Mr. Johnson, manager of the Royal Victoria Docks and Passage, and his men, who came to their assistance, as you will see by the *Donnybrook Sprig*, a paper published in the Fair, which I enclose. I also send you two Cork papers to show you how Cork lay opinion went.

Thanking you in anticipation for your insertion of this correction,

Arthur Percival,

Electrical Engineer, Lady's Well Brewery, Cork.

[We have read the comments in the papers sent us by Mr. Percival, and they appear to agree with what he says on the matter. The information published in our last issue was furnished by the contractors themselves.—Eds. Elec. Rev.]

Fire-box.—If the writer of the letter with this heading will kindly send us his name and address, not for publication, but as a pledge of good faith, we will publish his communication.—Eds. Elec. Rev.

LOANS FOR MUNICIPAL ELECTRIC LIGHTING.

At Tuesday's meeting of the London County Council, the Finance Committee reported as follows: "We have again to report upon the question of the periods for the repayment of loans obtained by vestries and district boards for electric lighting. It may be well, first of all, to remind the Council of the history of this question and of its present position. In 1891 the Vestry of St. Pancras applied to the Council for loans of £10,000 for the purchase of a site and £60,000 for the construction of electric lighting works, the repayment of the former to be spread over 60 years and of the latter over 42 years. At that time the Council had power to lend to vestries for 60 years for the purchase of land, but only for 30 years for the erection of buildings. The Council, being anxious to meet the views of the Vestry, sanctioned the borrowing of the latter sum for 42 years, and as it could not itself lend for that period, resolved to apply to Parliament for powers to advance money for electric lighting purposes for periods not exceeding 50 years. This power was applied for in 1892 and obtained, but it was understood as between the Treasury and the Council that the period to be actually fixed under the provisions of the Act should be determined as freely as if the extended period had not been named by the Act. On July 25th, 1893, we recommended the Council to sanction and make a further loan of £15,400 to the Vestry of St. Pancras, repayable in 42 years. The sanction was given, but the Vestry did not take up the loan from the Council. On January 30th, 1894, the Council considered a further application by the Vestry for the loan of £30,000 (including the above-mentioned £15,400), but on this occasion, after consideration of the whole subject, and of the views expressed by the Treasury, we recommended that the loan should be granted to the extent of £29,700 (on condition that the previous sanction of the Council to the borrowing of £15,400 should not be further acted upon), and that the repayment should be restricted to various periods according to the life of each portion of the works. After discussion in the Council this report was withdrawn. We again reconsidered the whole matter, and brought up a report to the Council on February 12th, 1894, recommending that the repayment of the whole should be spread over 25 years. An amendment to substitute 30 for 25 was lost, and our recommendation was ultimately adopted. On June 26th, 1894, the Council considered an application by the Vestry of Hampstead for sanction to a loan of £24,400. We recommended that the sanction should be granted subject to the repayment of the whole sum being spread over 25 years, but the Council in this instance substituted 42 for 25 years. After this decision of the Council, we felt bound to adopt in all cases the period of 42 years for initial electric lighting works, and therefore recommended the Council to advance to the St. Pancras Vestry for 42 years the sum of £14,300, the difference between the £29,700 sanctioned on February 12th, 1894, for 25 years, and the £15,400 on July 25th, 1893, for 42 years. The Council adopted this recommendation, and application was accordingly made to the Treasury for approval of the advance by the Council. The Treasury replied (see letter dated July 28th, 1894), practically to the effect that they could not sanction the advance of this loan by the Council for so long a period as 42 years, and we therefore directed our attention to the question whether any new proposal could be made which would be acceptable to the Treasury and which the Council might be willing to adopt. The contention of the Treasury was that no period should be granted which was disproportionate to the life of the works, and in order to arrive at a definite understanding on that point we carefully investigated, with the assistance of the engineer, the question of the durability of each portion of the work in greater detail than had hitherto been done. We were advised that the following division of the work in the St. Pancras case might be taken as being fairly accurate: £3,800 for meters and connections lasting five years; £4,000 for batteries lasting eight years; £2,000 for arc lamps and cooling apparatus lasting 10 years; £13,000 for boilers, covered mains, &c., lasting 15 years; £24,000 for engines and dynamos lasting 20 years; £33,000 for culverts and bare copper mains lasting 40 years; £9,000 for buildings lasting 60 years; £10,500 for land; total, £99,300. We thought that it might fairly be argued that as Parliament extended the maximum period for electric lighting purposes from 30 to 50 years, it was intended that at any rate some portion of the expenditure should be spread over 50 years. On the other hand, it could not be considered right to spread over 50 years expenditure of so short-lived a nature as meters and apparatus of that kind. We therefore came to the conclusion that the Council might be advised to adopt two periods for loans for the initial cost of electric lighting—viz., 50 years for all expenditure on land, buildings, culverts, bare copper mains, and patent royalties, and 20 years for expenditure for all other purposes. The comptroller, by our instructions, communicated with the Treasury suggesting these terms and stating

the considerations which had led us to decide upon them, and the Treasury has, with only a slight modification, agreed to our proposal. We present copies of the correspondence with the Treasury. We think the Council would desire that a definite agreement should now be arrived at between the Treasury and the Council, as to the terms for which these loans are to be sanctioned and made, and as the Treasury has signified its consent to the more favourable proposals of the committee, we recommend the Council to pass the following resolution: "That the periods of repayment of all loans for the initial cost of electric lighting undertakings be limited as follows: for land, buildings, culverts, bare copper mains, and royalty licenses relating to such purposes, 50 years; for all other purposes, 20 years.'" This was agreed to.

CANADA AND THE PACIFIC CABLE.

The conditions under which the Canadian Government recently advertised for bids for the construction of a Pacific cable were framed at the colonial conference held at Ottawa during the summer. It was the opinion of the conference that telegraphic communication, *free from foreign control*, should exist between the Dominion of Canada and Australasia, and that Her Majesty's Government should be requested to begin at once suitable surveys of the Pacific, the cost to be borne equally by Great Britain, Canada, and the Australian colonies. The Canadian Government was requested, meanwhile, to invite proposals from cable manufacturers, and generally to promote the establishment of the undertaking, the preliminary expenses incurred to be shared by the other colonies.

It is probable, says the *India-Rubber World*, whatever may be the outcome of the present movement, that the first cable to cross the Pacific will be a result of such considerations as influenced the conference at Ottawa. Two potent reasons now discourage the investment of private capital in the building of a Pacific cable; the great length of line and consequent cost as compared with the Atlantic cables, and the fact that every important commercial centre on the other side of the Pacific is already in telegraphic communication with the rest of the world by some other route. But while commercial necessities alone may not yet be such as to call for a Pacific cable, there may be political reasons of sufficient weight to bring governmental aid to the undertaking.

The map of the world is dotted with British colonies, and without an important exception these are connected by wire with the commercial and political centre of the empire. The question of placing a colonial dependency in closer touch with the mother country has not been decided always by the prospect of immediate profits from the connecting link. "It is not good politics," said Lord Rosemont in Parliament, fifty years ago, speaking for the Government, "to allow American ships to carry our mails across the Atlantic," and American ships have never carried them since. The same national spirit makes distasteful to Englishmen the fact that every existing telegraph line to their colonies in India, Australia, and South Africa somewhere passes over foreign territory. But with the lines now connecting England with Canada, and crossing Canada to the Pacific, a cable thence to Australia would connect with existing lines to every one of the colonies referred to, without touching other than British soil. This point was an influential one with the delegates at Ottawa.

But as a business proposition Englishmen may conclude that this is the time to build a cable across the Pacific. The French have made an actual beginning, used now as a basis for inviting more capital, and there have been rumours of such a thing as the annexation of Hawaii to the United States, and the building of an American cable to strengthen the bonds. Certainly one Pacific cable would be enough in our time, and the British must be first, or wait a long time before they have another chance. It may be added that the scientific standing of Mr. Sandford Fleming, who is promoting the Canadian Pacific cable, is such as to help the cause, and the same is true of the interest already manifested in it by the head of the great Siemens cable-laying firm.

FUTURE ELECTRICAL DEVELOPMENTS.

Mr. Ferranti has been before the Royal Scottish Society of Arts, Edinburgh, lecturing on this subject. He treated it in an earnest, sober manner, although not very profoundly. As his audience would include few engineers and fewer electricians, he evidently carefully avoided technical details.

Touching upon electrical heating and cooking, and upon electromotive power and traction, he declared that electricity at present was too dear to admit of the general adoption of these developments. The whole tenor of the speech was—cost of electricity—upon that depended all future developments. At present the cost is such that electricity is used only for lighting, and that only in the best streets and finer buildings, shops, and better class residences, so that the present movement has a limit very soon reached, beyond which the demand for electricity cannot increase unless some reduction in cost is made.

Mr. Ferranti does not hold out much hopes for the immediate realisation of his dreams about cheap electricity. He says: "For the present engineers must go on as they have already been going." He admits that the steam engine cannot do better, we cannot improve it, but he has great hopes that the gas engine will effect a mighty improvement, an opinion which we heartily endorse. We have often pointed out in these columns the advantages of gas engines. Then why should engineers go on as they have been doing using steam engines? We are afraid that the engineers handling the municipal electricity works in their initiatory stages do not trouble themselves much about the question, it is evidently easier to copy what has been done elsewhere, than to work out a better solution of the problems.

Turning to the central station, Mr. Ferranti enquires whether anything can be done there to cheapen the supply; but here again we are led into a *cul-de-sac*, and the familiar load factor meets us. No prospects are opened out whereby we might look for a solution of the load factor difficulty. The general state of idleness of the plant accounts for a good deal of the high price.

An important point is reached when the lecturer states: "We will require the plant of the future to be four times as powerful as at present for the same money, and this I do not think is a thing about the realisation of which there is much doubt."

We agree emphatically on that point and go farther by saying that we are convinced that many of the municipal plants put down cost far more than they are worth. Under the present conditions of deferred payments, and consulting engineers' fads, whims, and preferences, the firms that can enter into contracts for supply of plant are very few, and they have it all their own way in prices.

That the plants four times as powerful for the same money which Mr. Ferranti believes can be produced we have every reason to endorse; but will they be introduced? Perhaps, in time; and it is taking one long stride towards their introduction when an engineer of Mr. Ferranti's standing publicly states that such improved plants are realisable. We may have come to finality in steam engines and boilers, but we have by no means reached finality in gas engines, alternators, and dynamos, and other details, and by better systems of manufacture, perfect design, and following most recent knowledge, a considerable reduction in first costs can easily be effected.

No proposal towards levelling down the load curve is made, storage not being mentioned. Now, we believe storage to be one of the greatest of all future developments, indeed, to our mind, it is the only conceivable remedy for the load factor difficulty. We admit that storage as at present practised is not of much use so far as meeting the great variations in load, but it is an ideal which we must ever keep before us.

Another very important point is reached in reference to the distribution of the electricity. Upon the system of distribution adopted cost depends, but Mr. Ferranti passes very lightly over this part of the question. It must be evident to him, as it is to us, that the systems of distribution are at present all governed by the accidental limitations imposed by the manufacture of 110-volt incandescent lamps, and that whatever pressure may he used for transmission, 110 volts must be used for distribution, so we find both continuous and alternating systems using the mass of low pressure mains just as if no transformers had ever been invented. The high pressure and transformers as now used, save only a trifle of copper in a few main feeders; we confess that we do not see where Mr. Ferranti hopes for an improvement in this direction. So long as the distribution mains required are for 110 volts, the great expenditure in mains must go on. It has been found necessary to use much more copper in the three and five-wire systems in practice than was to be expected from theoretical reasons, and no other systems are practical at present.

We believe the desire to use electricity exists universally, and that the public require no educating up to the use of it; what they require educating up to at present is to adopt its use at 6d. a unit.

Judging from the repairs, the cost of supervision and wages for attendance, and the troubles with dynamos and alternators, and the explosions in mains, &c., the educating of the engineers up to the installation of better plants on better methods would, we think, also go a long way towards cheapening the cost of electricity.

Such lectures coming from a thoroughly practical engineer of considerable experience are of great value, dealing as they does with points around which the interest of engineers is at present concentrated. It is very different from those optimistic speeches raving about electricity as "the poor man's light," "the harnessed giant," applying "that mysterious unknown force," commonly delivered before corporations and others by the expectant consulting engineer.

THE BOARD OF TRADE INQUIRY INTO THE CITY ACCIDENT.

Major Cardew, on behalf of the Board of Trade, opened an inquiry, on Monday morning, into the circumstances and causes of the accident which took place on the 10th inst., when several persons were injured and a horse was killed. The accident, as briefly recorded in our last issue, was one in which several persons received severe electrical shocks, and others were injured by fragments of a broken street box lid. Great interest was manifested in the proceedings, and many prominent electrical men watched the inquiry.

Mr. Wallace, instructed by Ashurst, Morris, Crisp & Co., appeared for the City of London Electric Lighting Company; Mr. Russell Griffiths appeared for the Aldermen and Commissioners of Police for the City of London, and Mr. Baylis for the Commissioners of Sewers.

The first witness called was

George Clark, the driver of the horse which was killed. He said he was driving a brougham along Cannon Street about 1 o'clock on the 10th inst. When turning into Budge Row the horse slipped suddenly forward, turned over on its side, and its legs stiffened;

the body of the horse quivered a good deal. He jumped down from the box, but immediately felt a shock in both legs; he could not get near the horse on account of the painful nature of the shock. There was nothing to be seen on the pavement in the way of smoke, nor did he hear any noise. Afterwards he disconnected the traces from the horse and brougham and backed the vehicle away. In answer to a question, he thought the horse struggled for about four minutes; it foamed at the mouth, and bled a little at the nostrils, and before it died, groaned. He had not been able to work since the accident, and was still under medical treatment. Asked about the explosion, he said that shortly after they moved the brougham round he heard a rattling noise, and saw smoke issuing from a street box near 20 and 21, Budge Row.

By Mr. Griffiths: He did not drive over any metal plate. The wood pavement was very damp at the time. The brougham belonged to Mr. Boutland, of 24, Cousin Lane, Thames Street.

James Hutchings, warehouseman, employed at 21, Budge Row, said he was standing on the loophole at the above address, looking into Cannon Street. He saw a brougham come round the corner from Cannon Street. The horse stumbled forward on to its knees and nose. He jumped down to render assistance, and when passing the horse he felt a shock. He put his hand on the ground to save himself from falling, and felt a shock as though his arm was broken. He could hear a rumbling under the ground for 20 yards. About 10 minutes afterwards he saw an explosion occur, and a lid of a street box, in Budge Row, near the Liberator, was blown up.

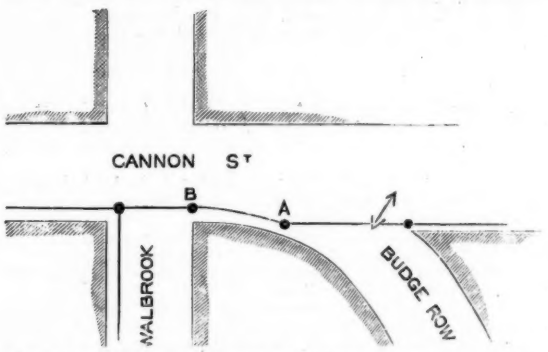
Major Cardew: What is the Liberator?

Witness: The Liberator Bank that went wrong some time ago. Continuing, Witness said the lid was blown up a height of about two feet, and fell to the ground. He saw smoke issue from the box, and heard a rumbling noise.

By Mr. Baylis: He saw the other explosion near Walbrook, where the roadway was forced up. The second explosion occurred half an hour after he received his shock.

By Major Cardew: He did not feel any shock when he reached the other side of Budge Row.

Charles Joseph Willy, a postman, said he was going along Cannon Street, from Queen Street, about ten minutes past one on the day in question. He was walking about six yards behind the brougham referred to by the first witness. He saw the horse fall and



A, Street box in Budge Row, where the explosion took place; B, street box at corner of Walbrook in which the explosion took place. The arrow indicates roughly the position of the horse when it fell.

a few people standing by. In trying to pass he stepped on the iron cover of a street box on the west side of Budge Row, and received a shock through the whole of his body. It drew him towards the ground, but did not knock him down. While in Walbrook, speaking to a gentleman, he saw flagstones fly up into the air, and a piece struck him on the finger, and some iron struck him on the toe, and he was hurled across the road to the other side. His mouth was filled with concrete, so much so, that he did not want any dinner afterwards.

By Mr. Griffiths: He was knocked almost senseless. The pavement was much disturbed, and the cover of the box was blown to pieces. He could not remember that he noticed any smell of gas at the time of the explosion.

Mr. H. M. Howell, a clerk, said that on the afternoon of the 10th inst. he was standing at the west corner of Walbrook and Cannon Street when the explosion occurred. He became very dazed, and had a peculiar burning sensation in his body. He had an umbrella in his hand at the time, and did not know what became of it. He saw one man lying on the ground, and heard him groaning. He did not smell any gas.

By Mr. Baylis: He had a nasty cut on the knee, and his right elbow was bruised. He found fragments of concrete in his pockets.

Mr. W. F. White, builder and contractor, of West Ham, gave similar evidence as to the explosion.

Mr. P. C. Wilkinson, 9, Canterbury Road, Brixton, stated that when he saw the horse fall he received a shock in both legs. After he had gone about one yard the shock ceased.

Mr. A. Haslett, mining engineer, 64, Cannon Street, said he saw the horse lying dead, and he noticed a boy, who was near it, receive a shock. He told a police-constable there was a good deal of danger, and whilst speaking to him the explosion occurred. The explosion lifted the lid of the manhole, and there were two or three other explosions in quick succession, dark smoke issuing from the hole at the time, together with blue flashes.

Major Cardew: Was it like a gun going off?

Witness: It was like three guns one after another, but the smoke continued afterwards. The flash was only momentary.

Was it an ignition of gas?—It was an electric flash; there was no doubt about it. It was not a gas flame. He saw nothing of the Walbrook explosion, but heard it. In making for the pavement, after telling a constable to switch off the electric current, he received a severe shock in his left leg, and was thrown to the ground. He went to Guy's Hospital, where he was put under electrical treatment.

The enquiry was continued in the afternoon.

Alfred Neal, a boy, spoke of the accident in Budge Row. He was walking from Queen Street along Cannon Street, when he saw the horse fall. When he went towards it a funny sensation went up his legs. He stepped back quickly, and the shock ceased. He walked across to the manhole, and when near it he felt another sensation. His foot was not on the manhole, but near it; one foot being on the wood pavement and the other on the kerb. The shock was felt in both legs, and it doubled him up. He lost consciousness, and was taken to the "Cannon" public-house. When he came out, and looking towards Budge Row, he heard a pumping like an engine, and volumes of smoke was coming out of a hole in the ground. This went on for half a minute, and then there were two loud bangs, followed by a blue light. He was certain about it being a blue flame.

In answer to Major Cardew: He heard a rumbling underground.

By Mr. Griffiths: He moved down the pavement to see the explosion.

By Mr. Wallace: He was in bed on Sunday, and felt sick on Monday. He had a bruise on his thigh, but did not know how it got there.

Constable Bradley, 665, City Police, said that about ten minutes past one on the 10th inst. he was on duty in Cannon Street, when he saw a crowd collecting. He went there, and saw a horse lying apparently dead. He was taking the names of driver and owner, when he heard two loud reports very near together. He saw the lid of the box opposite No. 20, Budge Row, lift up about 2 feet from the ground. This was followed by a bluish flame and dense smoke, which seemed to rise about two yards in the air; the flame continued for quite a minute. He then left to inform the electric light company at Worcester Wharf, Thames Street. He had no instructions to inform the company in case of accident. He went close to the horse, but only felt the shock slightly. His boots were wet, having been on duty since 9 o'clock. The shock did not prevent him moving. The coachman did not complain of suffering. He did not see anybody injured, but on returning to the scene of the accident Mr. Haslett complained of injury, and he took him to Guy's Hospital. He could not walk without assistance. The witness did not see the Walbrook explosion, but heard it; in fact, this explosion followed immediately after the Budge Row one.

By Mr. Griffiths: He felt sure that these explosions came close together; one was from Budge Row, and the other from Walbrook. He did not detect any smell when the flame rose in the air. The officials of the company went back with him to Budge Row. The horse was still lying there. The officials examined the boxes. He was away about five or six minutes.

Sergeant Cooper said he was on duty on the 10th about 1.20 o'clock in Cannon Street, and heard an explosion; he went towards Budge Row, and there saw dense smoke arising from the street box; the lid was displaced. He went on to Walbrook, and there saw the lid of the box, which was broken up and thrown into the road; the kerb stone was displaced and lying on its side. While standing at the corner of Walbrook he heard a slight explosion, which appeared to come from the Budge Row box; smoke still continued to issue from this, and altogether kept on for about ten minutes. He gave directions for the removal of the injured to the hospital.

By Mr. Baylis: He looked into the Walbrook box; the brickwork was displaced, the paving stones were only slightly displaced.

Mr. Frank Withers, the son of a proprietor of a shop, 22, Walbrook, said that shortly after one on the 10th, he heard a subterranean noise like a dull rumbling, which was immediately followed by a loud report. The stone covering was blown into the air, and the pavement displaced. He saw a bluish flame and smoke coming from the box; the basement window was broken, and the shop sun blind injured. The smoke smelt like burning tar; the hands in the basement had smelt the burning for an hour before the explosion. The iron of the sun blind, which was down, was broken.

Two more witnesses, Loveland and Moody, were unable to attend on account of injuries received.

Mr. Griffiths at this stage introduced evidence of former explosions.

Police-constable Carter, 777, City Police, was on duty on October 14th, 1892, in Great Tower Street. At five minutes to nine he heard a report, and went to opposite 17 and found a man apparently insensible, and saw the lids of two boxes displaced, five yards apart. He accompanied the injured man to Guy's Hospital, who was seen by the house surgeon. There were some repairs being made by the Gas Light and Coke Company in this street. He smelt gas, and that was the reason they were opening the roadway. When he heard the explosion he saw the lid of the box level with the top of the electric lamp. It was his duty to make a report of unusual incidents, and he did so on this occasion.

Mr. Griffiths read the report.

Police-constable Hoad, 504, now 368, said that on Monday, January 8th, 1894, an explosion took place in a test box in St. Paul's Churchyard, and Police-constable Robinson deposed to the accident which occurred in Ludgate Hill on the same day, when a man was injured.

Police-sergeant Phipps deposed that on March 11th, 1894, a box opposite 133, Cheapside, blew up with a loud report, due, apparently, to an escape of gas. His back was to the box when the report occurred.

These reports were put in by Mr. Griffiths.

Mr. H. Freeman, employed as assistant to Mr. Withers, said on the 10th inst., between eleven and one, he went into the basement; on several occasions he noticed a smell similar to burning India-rubber.

He thought it was something which had been put on the fire. He did not know where the smell came from. He was present at the explosion; the smell of burning India-rubber continued after the explosion. There were about six people at work, and nobody complained of the smell.

Technical Evidence.

Mr. David Cook, the engineer and manager of the City of London Electric Lighting Company, handed in a diagram of the connections of cables on the day of the accident; also a map showing the area and the whole length of the Benetfink primary main which went wrong on that day. This main goes past Budge Row.

Mr. Cook read a written statement, which was to the effect that "the primary cause of the accident was the crossing between two junction boxes in Queen Street of two high pressure cables, which were being tested and put to work for the first time. One of these cables was for the supply of current to the Watling Street transformer station, and the other for the Milk Street transformer station. The Milk Street cable was inadvertently put into the Watling Street terminals at Bankside, while the Watling Street cable was laid with its inner conductor touching the lead covering of a third cable leading to St. Andrew's Hill transformer station. For convenience, the Watling Street cable was made alive by current from the transformer station. When the signal was given, the man at the transformer station switched on. The inner of the conductor, as already explained, was against the lead covering of the St. Andrew's Hill cable, and, therefore, the inner of the whole high-pressure system was put to earth, throwing an unusual strain upon the outer to earth insulation of the primary mains. Our cables are all tested to a much higher pressure than anything that can be put upon them by a mistake of this kind; but, unfortunately, a rubber cable, supplying the Benetfink transformer station, broke down in a junction box at the corner of Cannon Street and Budge Row. The cause of the breakdown appears to have been due to mechanical abrasion of the outside covering. When the mistake was discovered, the attendant at the transformer station cut the cable out, but before this was done the leak in the junction box had developed into a short circuit. This appears to have fired some gas which was in the conduits, and blew up the cover of a box at the corner of Walbrook, some 60 feet distant, and also moved the box cover opposite 20, Budge Row.

"Since the explosion occurred at St. Paul's Churchyard, we have had men constantly employed searching for gas in our conduits. Four times since March last we have written to the gas company complaining of gas leakages in Cannon Street, within 100 yards of the spot where the explosion took place. Since January last we have written to the gas company 88 times, calling their attention to similar leaks all over the City."

Tuesday's Proceedings.

Major Cardew said he would take it that all the high pressure cables were concentric. In a concentric system, so long as no fault developed, the pressure on the outer should be equivalent to that of the earth. The effect of having the inner to earth was to force the effect the other way. Major Cardew said: With regard to the mechanical abrasion, was the cable bent at this spot?

Mr. Cook: It was not bent sharply, but the men had been working a good deal in that box, and in his (Mr. Cook's) opinion, the cable had rubbed against the edge of the pipe. Mr. Cook then spoke of the tests to which they subjected the cables; the inner of the concentric would be subject to 10,000 volts pressure between the inner and outer conductor, and between the outer conductor and earth there would be a testing pressure of 5,000 volts. The cable which broke down was supplied under a specification which required a test of the outer of 5,000 volts when immersed in water. The fuse on the Benetfink cable was calculated for 700 ampères; the horse-power would be 2,000.

Major Cardew said: If the only provision for dealing with a breakdown was a fuse which would allow 2,000 H.P. to pass before it acted, serious consequences might result. Mr. Cook admitted that, under some circumstances it might. The total load of the Benetfink station was 13,409 8-C.P. lamps actually wired. About 70 per cent. might be used, that is to say, 9,386. The primary current to light 10,000 lamps would be about 150 ampères. Crosby Square station was on at this time. There are 12,311 lamps connected, and 70 per cent. would give 8,617. Rood Lane Square was on with 8,697; 70 per cent. would be 6,087. It was possible for current from Benetfink to feed on the fault, as well as from Bankside, due to the interconnecting arrangements.

Asked whether it was necessary to maintain this interconnecting arrangement during hours of ordinary work,

Mr. Cook said they were making provision to do without this as soon as the system of mains was complete. They had telephonic communication between the central station and some of the transformer stations.

Major Cardew suggested if they controlled everything from Bankside, could not they arrange for extra fuses. Major Cardew said that what occurred to him was, that it was dangerous at light load to send current through a fuse which would carry 700 ampères before it acted.

Mr. Cook said they would not, at light loads, have much horse-power going from the station.

In reply to Major Cardew, Mr. Cook said there was nothing to indicate that the pressure had risen on the outer conductor. An electrostatic voltmeter was not being used at the time of the accident. The street boxes where the explosions occurred were not ventilated. There were, however, a number of telephone tubes which, in his opinion, gave a current of air from box to box. The boxes had been frequently inspected.

Major Cardew read Regulation 15, which provided for the prevention of the electrically charging of any metal portion of the box near the road.

Mr. Cook said he would admit that the regulation had not been altogether complied with. When these cables were first laid, this aspect of the question did not occur to them to be so important as it did now. They had found it better to put in armoured cable. He had given orders to cover all the parts of the cable between the two pipes, *i.e.*, portions not in the pipes, with copper strip securely connected to both ends of the pipe. There would be several layers of copper strip securely fastened to each pipe. His experience was, that in distributing with alternating high pressure currents they must have concentric cables metallically covered throughout its whole length. He thought a good thick lead covering would suffice.

Major Cardew suggested that the melting point was rather low in lead.

Mr. Cook did not think it necessary to have steel armouring outside. The new cables were lead covered, but not armoured, laid in iron pipes.

Major Cardew then read regulation 15, which also provided that the boxes should be kept free from gas and water.

Major Cardew: You think that this was sufficiently met by inspection and air in the telephone cables?

Mr. Cook: He thought so. The accumulation of water was provided against by puttying the joints of the cover and removing the water. He had given orders for a regular inspection.

Major Cardew called the attention to regulation 8, which provided that the high pressure cable should be not less than 18 inches from the surface of the ground, and the same with regard to any low tension cable, and efficient means should be taken to prevent the ground or low tension cables becoming electrically charged. As regards regulation 8, he would like to know the depth of the cables below the ground in Budge Row?

Mr. Cook said at the Cannon Street end they were at a depth of 2 feet 6 inches, and at the end of the slope 1 foot 4½ inches. The low tension cables in the bitumen casing were close to the high pressure ones, but they were not damaged. He accounted for the smoke by the burning of the rubber. He rather discounted the evidence of the non-technical witnesses as to the quantity of smoke.

Mr. Cook, in reply to Major Cardew, considered that the regulation had been sufficiently complied with as regards low pressure cables, but they would adopt further precautions to make assurance doubly sure. Asked as to whether he had anything further to say about precautions he had adopted, he said he was going to ask his directors to put in a complete system of ventilating pipes.

Major Cardew asked whether means were taken to identify the cable which was made alive by the current from the transformer station?

Mr. Cook: No means were taken to identify the cable. It was taken for granted that it was right. He admitted that it would have been better to have switched through a fine fuse in the first instance.

Mr. Wallace here read a letter dated May 18th, 1892, from the Board of Trade, with regard to regulations for protecting the public and efficient supply of electricity.

Mr. Cook said the date of the contract which was entered into was December 8th, 1892, but cables had been laid before this date.

Mr. Griffiths wanted to get at the fact whether all, or part of, the system, was approved by the Board of Trade?

Major-General Webber, interposing, said at the time of the first contracts the provisions of the regulations were understood.

Mr. Cook, examined by Mr. Griffiths, admitted it would have been quite simple to have identified the cable by an electrical test; that was the mistake made. The ground was electrically charged, and the means taken to prevent it were inefficient. The company looked to the Board of Trade to prescribe for the safety of the public, and not to the local authority. No street box was ventilated, except as described, that was by telephone cables.

Major Cardew, at this stage, read extracts from his report of the explosion, January 8th, 1894. When he investigated that, he pointed out that in the large street boxes the regulation had not been sufficiently complied with. The company replied that they were maturing a scheme of ventilating pipes to run up the houses. It had never gone beyond that.

Mr. Cook said the system of inspection was carried out. They did not hurry with it, thinking precautions adopted were sufficient.

By Mr. Wallace: They had no power to run up houses.

Major Cardew: It was their own suggestion.

By Mr. Griffiths: He knew nothing of suggestions made by the Laing, Wharton & Down Company for the ventilating of the mains by closing up ends of the pipe, and ventilating by the lamp-posts. He considered it dangerous, because the explosion would be in a confined space, and gas passing up the lamp would be dangerous. He did not know of a letter from the Brush Company on the same subject, in which they said they would obtain ventilation by making pipes and boxes airtight, and ventilating in the same way as proposed by the Laing, Wharton & Down Company. He considered the system of primary mains in the area supplied by the Benetfink area was sufficient at the time; they were extending, and the cable would be relieved by passing current through new mains. In his opinion the regulations of the Board of Trade were reasonably complied with against danger to the public. The electrostatic voltmeter would have shown something wrong if there had been anybody there to read it; it would not be difficult to arrange for it to give an alarm. Asked about injury to the cable, they would not take any notice of the appearance of a cable if it was all right when tested.

By Mr. Baylis: With regard to the explosion in Great Tower Street, he no doubt heard of, but had no recollection of it. Had no recollection of any gas explosion before January, 1894. The circumstances of the Ludgate Hill explosion were investigated by him. Admitted receiving letter, September 18th, 1894, from the City engineer, pointing out contiguous high pressure and low pressure mains. He replied that the matter was before them; he had arranged with

Major Cardew to put metal in the boxes, which would be done as soon as drawing-in was complete. The letter concluded that there was no danger likely to arise from the contiguity of high and low pressure cables. The cable which broke down was of first-class manufacture.

By Mr. Wallace: He considered that there would be a far greater number of people killed by falling over orange peel than would ever be killed by electricity. They had never killed anybody out of the works. He had heard of a similar accident at Bournemouth. A horse by reason of its long stride and metallically connected to the ground, would be more liable to get a greater shock than a human being. With regard to ventilation, they were going to propose to utilise the guard posts at corners of streets for ventilating purposes. They spent a lot of money in making joints in the cables as perfect as possible. If the Commissioners of Sewers allowed them to use the guard posts, there would be no danger of explosion. He did not anticipate any difficulty in getting this permission. The system of intercommunication would be kept as a reserve, and that would be done as quickly as possible. All cables are tested by the manufacturers and then the company. If there is a fault after this, it would be a latent one. He was going to make regular tests in the future at a much higher pressure than the ordinary working. They had spared no expense in adopting precautions to ensure the safety of the public. They were supplying more high pressure current than any other company, and in a very dense area. New problems arise which they took every means of solving.

The Chief Engineer of the Gas Light Company, interposing, said that there was no gas which had escaped in the vicinity. Their inspector was on the spot immediately after the accident, and the ground was examined by means of searching rods; they used Ansell's leak detectors, but there was no trace of gas. The experiment was repeated on the following day with a similar result. They searched in the vicinity of the electric light main. This system of searching for gas was generally successful under hermetically-sealed pavements, as in this case. He thought if there had been an escape it would have shown itself in the box since, but they had had no notice from the electric light company with respect to that box.

By Mr. Wallace: He admitted that the test was not altogether certain on any occasion, because it assumed a hermetically-sealed pavement. The most explosive mixture would be 90 parts of air and 10 parts of gas. Within 5 or 7 per cent. of more gas it would burn. If they had a mixture of 90 per cent. of gas and 10 per cent. it would burn, the illuminating power of the gas being minimised by the admission of the air.

Mr. Wallace said a test had been made in a box at Dowgate Hill, where it was found last night that 12 per cent. of gas existed. Did he know that the Walbrook box was connected to the Downgate Hill?

The Witness admitted that it was possible for gas to get in from one box to the other. The witness also said they had a good deal of difficulty in Cannon Street in their mains, resulting from excavations for the Inner Circle Railway from Mansion House to Aldgate. Asked as to what he thought of Mr. Cook's scheme of using the guard posts as ventilators, he was bound to confess that he considered it a bad one, on account of the danger of gas issuing in such a low post. He would suggest that if they were to use their arc posts and fill them up with earth or sawdust to prevent gas firing back and carry a 2-inch pipe, with an outlet to the atmosphere half-way up the post, there would be no danger of the gas firing back. This pipe would be connected to the conduit. He was sure that the gas company would help the electric light company in any reasonable way for the purpose of preventing the accidents. Asked as to the colour of the flame which had been mentioned by witnesses, he said that gas mixed with air would produce a blue flame, but in that case there would be no black smoke. The gas company would help in any way to investigate the cause of the accident. He considered that it was impossible to disturb the streets without causing occasional injury to the gas pipes.

Major-General Webber, C.B., said he recalled the reception of copies of letter referred to from the contracting companies to the Commissioners of Sewers, in which it was suggested that arc lamp-posts should be used as a means of ventilating street boxes. It was then decided that the suggestions were not feasible, and might result in danger. The whole question of ventilation of street boxes was gone into by me, following years of experience of telegraph street boxes and others. At first it was decided that each street box in the City should be provided with drain pipes, wherever the position was surrounded by wet soil. On reconsideration, after the experience of accident in Knightsbridge arising from leakage of gas, I decided that it was better to have an accumulation of water in a box than to leave any means of access for gas. The prevention of the entrance of gas into the boxes appeared to be the one measure essential to public safety, seeing that more than one House of Commons committee had declined, at the request of electric light undertakers, to allow clauses which would enable street boxes to be ventilated by attachments to private houses. He did not dispute that ventilation by an inlet and outlet pipe was not the very best thing. He was sure the very next best thing was to construct boxes as they were with vitreous and glazed bricks, and, contrary to what Mr. Cook has said, close all the unused pipes by wooden plugs or tarred yarn, or something of that kind. He made experiments as to annular space round a cable, or rather, the passage of gas through the annular space, with a view to see whether gas fired back. An explosive mixture would fire back but an inexplosive mixture would not. He thought it should not go before the public from this inquiry that these street boxes, even without ventilation, were a source of danger, because they were not so except in the most unusual circumstances. That was the conclusion he had arrived at, and it was particularly the case if the boxes were constructed in an air-tight manner themselves, and the passages between box and box closed by plugs. He had seen the plugs in at the Chelsea Company's mains.

Mr. Wagner, an analytical chemist, stated that he took samples of air contained in the box at the corner of Walbrook (about 8 o'clock on Monday, 19th), and one at the corner of Dowgate Hill. In the box at Walbrook he found no coal gas, in the other, at Dowgate, they found, approximately, 12 per cent. of coal gas. He was sure that he obtained a fair sample. He took one sample in the Dowgate Hill. At Walbrook they took about three pints in the two tests, and at Dowgate Hill about three or four pints.

By Mr. Griffiths: If there was that proportion of gas in the Dowgate Hill, if there were communication he should have expected to find some in the Walbrook box.

Major Cardew, asking which was the higher of the two boxes, was told that they were about level. It appeared that there was no direct communication between the boxes.

Mr. John Lister, traveller to Messrs. Woolf & Co., electrical engineers, stated on the day (11 o'clock) of the accident, passing down Cannon Street, he smelt gas very strongly opposite the Liberator office. He had noticed this on the previous day, about 2 pm. He mentioned the fact to two or three persons.

The enquiry was then adjourned until Friday morning.

BUSINESS NOTICES, &c.

Universal Electrical Directory (J. A. Berly's).—Messrs. H. Alabaster, Gatehouse & Co. have now in course of preparation the 1895 edition of this directory, which embraces all connected with the electrical trades throughout the Universe. It is indispensable to all having business transactions in the electrical world. Names and addresses for insertion, corrections, and orders for advertisements should be promptly forwarded.

Australia.—Messrs. Trackson Bros. have some extensive electrical apparatus manufacturing workshops in Adelaide Street, Melbourne. Their lathes, drilling machines, and shaping machines are run from a line of shafting driven by a 12 H.P. electric motor. They are at present carrying out contracts for lighting plant for four sugar-mills and one meat works, besides private house installations, involving in all the erection of 2,400 lights. Electric motors of various sizes are to be seen in different stages of construction from ½ to 4 horse-power. The position of this firm has recently been strengthened by the arrival from London of Mr. Philange Trackson, who has undertaken the responsibility of the engineering branch.

Bacup.—The Liberal Club has lately been fitted throughout with an electric light installation. There was a large gathering to celebrate the inauguration on the 6th inst. The installation has been put in by Messrs. Matthew & Yates, of Manchester, under the supervision of Mr. Thomas G. Slater, and comprises both electric lighting and electric ventilation. The motive power is derived from a gas engine of 8 nom. H.P., and this is connected to a Matthew and Yates compound dynamo, with an output of 80 ampères at 100 volts, working at 1,200 revolutions per minute. The engine and dynamo are situated in an out-house at the back of the club, in which also is fitted up a main switchboard and various other accessorial instruments. In the top billiard room there are six 25-C.P. lamps over each table, and round the room are six of 16-C.P. In the card room there are four 25-C.P. lamps; and in the committee room two of 16-C.P. In each of the three lavatories there are two 16-C.P. lamps, and there are five 16's on the staircases and landings. The lecture room has six 50-C.P. lamps, and one of 25-C.P. near the platform; and in the anteroom there is one lamp of 25-C.P. In the reading room there are five lamps of 32-C.P.; in the bottom billiard room six lamps of 25-C.P. over the billiard table, and four of 16-C.P. round the room; in the bar one lamp of 32-C.P.; in the hall one lamp of 32-C.P.; in the vestibule one lamp of 16-C.I.; in the lamp outside the club two lights of 50-C.P. each; and two in the engine house, each of 16-C.P.; making a total of 1,510 C.P. The ventilation is effected by means of electric air propellers, running at from 500 to 700 revolutions per minute. There is one 15-inch fan in the card room, another of equal capacity in the committee room, two of 18 inches in the lecture room, and one of 18 inches in the bottom billiard room. Mr. A. Wright's new offices across the road will also be lighted from the same source.

Bedford.—The order to instal the electric light in a portion of the Modern School House has been given to a local firm, Messrs. Kilpin & Billson, and the work is being carried out under the superintendence of Mr. J. Hardie McLean, M.I.E.E., of Oxford, who has been appointed the consulting engineer.

Belfast.—The engineer has been instructed by the Electricity Committee to use every effort to push on the work at present in hands of the contractors for the central station, with special reference to some engines not yet delivered.

The decision of the Great Northern Railway Company to utilise electric light appliances for the inspection of cattle on their arrival at Belfast after sunset has now been approved by the Privy Council.

Blackpool.—Two men were injured, but not seriously, here on Thursday evening last week from electric shock. A man was attending to the public arc lamp at the corner of Leopold Grove and Church Street when he came into contact with the current. A passer by, hearing his cries for assistance, mounted the ladder and clasped

his arms around him, endeavouring to draw him away. The would-be rescuer also received a shock, but was successful in bringing the injured man to the ground. The man is now all right again, excepting for a few severe burns on his arms.

Bray.—We are informed that electric lighting is making steady and sure progress here. Amongst a good many other houses lately supplied the local company have now almost completed the wiring of Dr. Donnelly's Presbytery, Bray, for 60 lights. We are led to believe that an extension of plant will shortly be necessary. Mr. J. D. A. Harris has placed an order with the Patent Exhaust Steam Injector Company, of Manchester, for a complete condensing plant for the Bray station.

Brentford.—At the last meeting of the Local Board a letter was read from Mr. Sowerby, of London Wall, asking upon what terms the Board would be prepared to grant him facilities for the installation of the electric light in the district. It was resolved that the clerk reply that the Board could not entertain the matter without further information.

Brighton.—Last week's gales did a certain amount of damage to Volk's Electric Railway. The cars were, however, running again last Friday, the necessary repairs having been effected.

Bristol. — The Assembly Room of the Royal Hotel, College Green, is now lighted by electricity.

Cheltenham.—Tenders are to be advertised for steam and exhaust pipes for the central station; some steam valves are to be procured from Messrs. Hopkinson & Co., of Huddersfield. The electrician (Mr. Kilgour) has reported that wiring orders had been placed in tradesmen's hands for 450 16-C.P. lamps, and that orders for another 300 would be given in the course of a few days. The authorities of Salem Baptist Church intended introducing the electric light into the chapel, lecture room, &c., and they have made suggestions to the Council for special arrangements for churches, chapels, and other large buildings. It was referred to the Borough Surveyor to report thereon. The Public Library Committee have been requested to take into consideration the question of introducing the electric light into the library. On the 24th ulto. the Borough Surveyor reported:—That, the transformers having been ordered, and the sub-stations commenced, it was necessary that the order for switchboards should be placed. The quotations were: The Brush Company, £210 4s. 6d.; Messrs. Siemens Bros., £376. He advised the acceptance of the Brush Company's offer. For testing the alternators, transformers and meters, an artificial load consisting of 100 incandescent lamps would be required, costing between £90 and £100, and he asked authority to obtain these as soon as the testing room is ready to receive them. They would also require to order from Messrs. Callender (who are supplying the cables), 20 sub-station joint boxes, and about 20 house service boxes at a cost of about £76. For purposes of supply, it would be necessary to hold a small stock of meters—there are already 14 certain customers—and an order should therefore be placed for at least 20 meters at once. Mr. Kilgour visited the Brush Company's works for the purpose of testing the transformers. The result was most satisfactory. The insulation resistance was very high, being about 10 times that required by the specification. The no-load losses were 95·9 and 69·4 watts for the two sizes respectively, which is less than the maximum allowed in the specification by 24·1 and 20·6 respectively. Only the smaller transformers were tested for pressure drop; the result being two volts as against 2·5 volts allowed in the specification. The full load losses cannot be tested until the transformers have been delivered. These tests are most satisfactory and there will be no difficulty in accepting the transformers as complying with the specification. It was resolved, that the tender of the Brush Company for the switch-boards for the sub-stations be accepted and that the other apparatus referred to in the surveyor's report be purchased.

Chiswick.—We have received the following letter from Messrs. Bourne & Grant regarding our last week's statement regarding affairs at Chiswick:—"We notice in your issue dated November 16th, a statement to the effect that 'The Chiswick Local Board have expressed to Messrs. Bourne & Grant their dissatisfaction at the slow progress made with the electric lighting works.' Permit us to contradict this statement. The Chiswick Local Board have done nothing of the sort. This is not the first time that you have given room in your columns for inaccurate statements in reference to us and the work we have in hand, but we cannot allow such a damaging and untrue statement as the one above quoted to pass without asking you to contradict it in your next issue by publishing this letter; and to be good enough if, in future, you think it necessary to publish any statements in regard to our work, to see beforehand that they are accurate. Perhaps you will permit us to add that there has been no delay in any of our works for which we are responsible, or for which we could be held in the least degree accountable.—Yours faithfully, Bourne & Grant."

With regard to the statement which Messrs. Bourne & Grant contradict, what we should have said was as follows:—"The Works Committee have reported with regard to the progress of the works at the electric lighting stations, and recommend that a letter be written to Messrs. Bourne & Grant expressing the dissatisfaction of the Local Board at the slow progress of the work. The surveyor said that the work had been stopped because Messrs. Bourne & Grant wanted to excavate a larger area of land for the work than was stated in the agreement. They intimated that they were not aware there was any limit fixed to the area of land to be utilised, and the works could not be proceeded with in the area mentioned in the agreement. Captain Alleyne said the best method to adopt was to ask Messrs. Bourne and Grant to submit plans of the work showing the area of land required. This was agreed to." Unless this statement is contradicted by Messrs. Bourne & Grant, we shall presume it is correct. Though our statement was not entirely right, it will be seen that the Works Committee, which is a body representative of the Board, thought there was cause for dissatisfaction, though their recommendations were amended at the meeting of the Board. The following is the version of the affair as stated by one of our London weekly contemporaries:—"The Chiswick Local Board have written to Messrs. Bourne & Grant expressing dissatisfaction at the slow progress made at the electric lighting station works." In regard to the other inaccurate statements said to have been published in our columns, we cannot look into them unless Messrs. Bourne & Grant favour us with particulars.

Colwyn Bay.—A member of the Local Board last week said he had heard that a private company had an eye on Colwyn Bay, intending to supply it with electric light. The Local Board forthwith decided to apply for a provisional order and keep the matter in their own hands.

Derby.—The Electric Lighting Committee report that the whole of the arc lamps for street lighting (76) are now in position. The total candle-power of street gas lamps displaced by these is 9,072. The effective light produced by the arc lamps amounts to at least eight times that of the gas lamps displaced. The price of electric current for purposes other than lighting has been reduced to 3d. per Board of Trade unit. Mr. F. L. Lister has been appointed assistant engineer, and Mr. Reginald S. Downe second assistant. Messrs. Siemens Brothers & Co., Limited, handed over the working of the station to the committee's staff on August 25th last, since which time it has been entirely worked by such staff. The mains and public lamps are still in the hands of the contractors. Thirty additional meters have been ordered. Continuous running is now carried out in accordance with the provisions of the Lighting Order, and the work is done in three shifts. The private lighting, the committee consider, promises to be a good business success. It is, of course, premature to positively make any statement, but when it is remembered that the present installation, so far as private lighting is concerned, is designed for 7,500 lights, and that 7,450 lights are already attached, and there are signed applications for 3,000 lights more, the conclusion that the public show a distinct inclination to take the light is inevitable. The committee regret that they cannot at present settle their accounts with the contractors, so that the exact amount of capital and annual expenditure can be ascertained, but they need hardly tell the Council that this will be done at as early a moment as possible. The expenditure of the committee is still within the amount granted by the Council (£35,000), but further expenditure will undoubtedly be necessary. The 250 horse-power engine and dynamo combined is now nearly completed, but the demand for current for domestic and business lighting purposes is already sufficient to absorb all that it will produce, in addition to the plant already at work. The machinery cannot well be increased to be of much service during the present winter, but early in spring the matter must have attention.

Govan.—The entrance to the Cessnock Dock was lighted up by electric light for the first time on Monday evening last. The lights are two in number, and are placed one on each side of the entrance to the new graving dock, at present under construction. They are each of 4,000 C.P. and are carried on poles at a height of 50 feet above the quay wall. The electrical energy is supplied from a dynamo and gas-engine within the shed at the dock entrance; the dynamo is of the Faraday type, and is driven by an Acme gas engine. The installation has been designed and carried out by the Faraday Electrical Engineering Company, Limited.

Hampstead.—The Vestry have accepted the offer of the Prudential Assurance Company, Limited, to lend the Vestry the sum of £24,400, for electric lighting purposes for 42 years, at 3½ per cent. with 15 guineas costs (excluding stamps).

Kendal.—In further reference to the question of electric lighting, we understand that the whole matter, together with the application of the Windermere and District Supply Company, has been referred to a special committee to consider and report.

Llandudno.—As we stated last week the Commissioners have determined upon applying for a provisional order, and are accordingly opposing the application of the company which was recently formed for the same purpose. A public meeting was held in the town on 14th inst., apparently convened by the company, to discuss the decision of the Commissioners and to elicit the opinion of the ratepayers thereon. There were arguments for and against, but in the end a resolution proposing to give the company support, was lost, so says the local paper, by a large majority. This repulse could hardly have been expected by the Llandudno Electric Lighting Company, and the very best thing the Commissioners can do is to push forward with the work as rapidly as possible, and endeavour to have everything in order by next season.

London.—The Bishopsgate Institute, which is to be opened next Saturday, is lighted throughout by electricity.

Motherwell.—At a special meeting of Motherwell Police Commissioners last week, it was agreed to procure a provisional order. It is estimated that the total cost of an installation will be £12,500.

Oldham.—On the occasion of the unveiling of a tablet commemorating the opening of the central station recently, the Mayor read the following statement showing the expenditure on the capital account:—Electric supply station: Land, including law charges, £2,893 9s. 5d.; buildings, £5,200 15s. 4d.; boilers, £991; economiser, £194 4s. 3d; engines, dynamos, crane, and feed pumps, &c., £5,781 15s. 6d.; condenser, £308; switchboard, £706; batteries, £638 12s.; electrical instruments, £198 6s. 11d.; reservoir, £793 1s. 1d.; engineering, £450; street expenses, £78 15s. 4d.; printing, adver-

tising, engineer's and sundry expenses, £256 8s. 11d.; total, £18,490 8s. 9d.; street mains and services, £6,372 17s. 4d.; costs of obtaining provisional order, £479 13s. 7d.; grand total, £25,342 19s. 8d.

Paddington.—The application of Mr. Whiteley for permission to hang electric lamps in front of his shops in Westbourne Grove, upon condition that the underside of the lamps be not less than 8 feet 6 inches from the footway, and that the same be fixed to the satisfaction of the surveyor, and remain only during the pleasure of the Vestry, has been granted.

Paisley.—Mr. Bryson, electrical engineer, has furnished the Corporation with his report as to the advisability of the Council exercising their electric lighting power. He states the cost would be four times the present price of gas, which is 2s. 10d. per thousand.

Reading.—The *Evening News and Post* last Saturday stated that owing to the floods in the district all work erecting the electric lighting company's station was suspended.

Taunton.—A Local Government Board inquiry was held last week in reference to the Town Council's application for permission to borrow £5,000 for the purpose of electric light extension.

Wandsworth.—Some weeks ago we recorded the intention of the District Board of Works to disapprove of certain details connected with the electric lighting installation of the County of London Company. The company later submitted another plan with a smaller number of transformer chambers. The General Purposes Committee, to whom the matter was afterwards referred, report having considered fully the County of London Company's application, recommended that when the matter went before the Board of Trade, the Board of Works retain counsel to appear in support of their objections. The Board of Works have also decided to inform the company that they are of opinion that all questions in connection with the proposed works should be settled before the work is commenced.

Warminster.—The Local Government Board have been applied to for sanction to borrow £250 for the extension of the electric light in the town.

Windsor.—After considering the report made by Mr. Shoolbred and the information supplied by the town clerk, the Corporation have decided to apply for a provisional order, the area to include the district of the Eton Local Board and to comprise the following streets:—High Street; Thames Street; and Peascod Street, as far as the junction with Victoria Street in Windsor; and High Street, Eton, as far as the gateway entrance to Weston's Yard in Eton.

Woking.—According to the *Surrey Advertiser*, the Sanitary Committee recently reported that at their last meeting a letter was read from Messrs. New & Mayne, in reference to the delay caused by inability to obtain certain parts of the machinery, and also a telegram stating that the same would be sent on the 9th. The clerk was instructed to write, informing them that a piece-meal installation would not be accepted, and pressing on them the necessity of using the utmost despatch. The report was adopted.

Yarmouth.—At the meeting of the Electric Lighting Committee on November 6th, the surveyor made complaint that none of the plant for private lighting had been delivered, and customers who had wired up their premises could not be supplied with current. The town clerk was directed to warn the contractors of the penalties under their contract. Four arc lights were ordered to be discontinued on the Beach. Four meters costing £35, and joint and fuse boxes at £50, were ordered to be procured. The customers for the light now number twenty, using 1,000 lamps. The receipts from these and from lighting of Corporation property would be £1,500, and the expenditure would be about £2,650 per annum, a deficiency of £1,150 per annum. In reply to a question at the Town Council's meeting, the surveyor said they had done better than they thought they would.

Affairs of J. G. Statter & Co., Limited.—In the Chancery Division, London, on Wednesday, the petition of the Bedford Engineering Company, for the winding up of J. G. Statter and Co., electrical engineers, came before Mr. Justice Vaughan Williams. Mr. Theobalds, applying on behalf of the company, said the business was being carried on by a receiver appointed in a debenture holder's action, and negotiations were pending for the sale of the business on terms which would be very favourable. This sale would realise something for the unsecured creditors, and he asked the Court to allow further time for the negotiations. Counsel for the petitioning company did not oppose this, and his Lordship adjourned the petition for one month.

Alley & Maclellan *v.* Latimer Clark, Muirhead & Co., Limited.—There was taken out of the Glasgow Sessions Court last Monday, an action by Alley & Maclellan, engineers, Sentinel Works, Polmadie, Glasgow, against Latimer Clark, Muirhead & Co., Limited, electrical engineers, 23, Regency Street, Westminster, London, for payment of £726 8s. 2d. for goods supplied to the defenders. The defender's firm is now in liquidation, and the pursuers' claim is to rank on the estate.

Auction Sales.—The sale of the Deptford station surplus stock, which was to be held on the 28th of this month, has been postponed until early in December.

Messrs. Fuller, Horsey, Sons & Cassell, will sell by auction, next Wednesday, a quantity of electric generating plant. For further details, see our advertisement pages.

Bankruptcy.—An application for an order of discharge was made last Friday, at the London Bankruptcy Court, on behalf of William Grigg, described as of 33, Eastbourne Terrace, Paddington. The bankrupt, who practised for over 30 years as a curer of diseases by the application of electricity, failed in 1883. The only proof lodged was one for £638 4s. 3d., and the only assets disclosed were the electro-magnetic machines used by the bankrupt and valued at £10. The bankruptcy was declared to be closed in April, 1884. No dividend had been paid to the creditors, and the bankrupt now applied under the Bankruptcy (Discharge and Closure) Act, 1887, for a release. There was no opposition to the application, and Mr. Registrar Brougham granted the usual order of discharge.

Book Received.—"American Electric Street Railways; Their Construction and Equipment with Notes as to the Cost of Installation and of Maintenance, Also the Advantages of Electric Traction Compared with Other Methods," by Killingworth Hedges. Published by Messrs. E. & F. N. Spon, 125, Strand, W.C.

Canal Lighting.—The North East Sea Canal will be illuminated with electricity. The lighting is to be so arranged that masts 12 feet high will be set up on both shores of the waterway, at a distance of about 820 feet apart. On each of these masts will be a group of 25 electric lights. The number of standards bearing these will be 1,000, and the glow-lamps to be used, therefore, 25,000. At different points along the route, where more powerful light will be required, the lights will be supplemented.

Drake & Gorham.—Among the more important installations which this firm has in hand at the present time, may be mentioned Londonderry House for Lord Londonderry, who entrusted the same firm with the lighting of Wynyard Park some two years back. A very large number of lights are being put in and the current will be obtained from the outside supply.

Epstein Accumulators.—The Epstein Electric Accumulator Company, Limited, inform us that in order to cope with the ever-increasing demand for their accumulators, they have taken new and extensive works at Milton, in Staffordshire, where their plant of 600 H.P. will enable them to execute even very large orders with celerity. The history of these accumulators, which were first manufactured in England some four years ago, presents an uninterrupted record of success, and, only recently, the company have again introduced important improvements. We understand that the prices have been materially reduced.

Moss Side New Tramway.—A local firm are desirous of erecting a new tramway through their district; the method of traction proposed is either gas motors or electricity. The firm in question have applied through their solicitors for the Local Board's sanction to their application for a provisional order. The board will discuss the matter shortly with the solicitors.

Stockport Union New Workhouse.—These buildings are to be lighted by electricity.

Sunderland Exhibition.—The mayor, Councillor John Sanderson, opened an exhibition on Tuesday afternoon of marine electrical engineering and general trades exhibits. This is said to be the largest exhibition of the kind ever held at Sunderland, and the crowded attendance at the opening function augured well for its success. Altogether there are over 300 exhibitors from all parts of the kingdom, and from one or two foreign countries.

Transformers.—The Manchester Edison-Swan Company, Limited, have just published a circular dealing with their transformers. There is given in the list a copy of a report made in March last by Prof. J. A. Fleming, upon a 3,000-watt transformer manufactured by them. This report is very favourable indeed, as will be observed by the following paragraph in which he sums up the results of his tests:—"This transformer has, in all the above tests, shown itself to be considerably above the average, even if not superior to any other transformer of this size which has come under my notice in this combination of small iron loss with small secondary voltage drop." Magnetic leakage in this transformer, he states, is practically absent. The list also gives prices of the various sizes of transformers.

CONTRACTS OPEN AND CLOSED.

OPEN.

Bristol.—Tenders are to be advertised for for lighting the Guildhall by electricity. The plans and report of Mr. H. Faraday Proctor was presented to the last meeting of the Electric Lighting Committee.

Cowpen.—December 20th. The Local Board want tenders for the lighting of a certain area by electricity or otherwise. For further particulars see our advertisements.

France.—A large exhibition is to be held in Bordeaux next year, from May 1st to November 1st, and the general secretary of the exhibition, in Bordeaux, is at present inviting proposals for the work of lighting and supplying electrical energy in the exhibition and grounds.

Spain.—December 20th. The Spanish Minister de Ultramer, in Madrid, is inviting tenders for the concession for the establishment and exploitation of a telephone exchange at Santa Clara, Island of Cuba.

York.—November 27th. Tenders are invited for the following articles during six months ending June 30th, 1895, delivered carriage paid at the company's telegraph stores at York, for the North Eastern Railway Company:—(1) telegraph apparatus; (2) telegraph wire and line stores. Further particulars may be obtained on application to Mr. Graves, Telegraph Department, York.

CLOSED.

Cheltenham.—The Town Council have accepted the tender of the Brush Electrical Engineering Company for switchboards for the sum of £210 odd. Further particulars will be found in our "Business Notices."

Paddington.—Application was recently made to the Local Government Board for their sanction to the expenditure of a certain sum for the electric lighting of the male wards and administrative block at the Infirmary. This has now been granted, and the tender of Messrs. Spagnoletti & Crookes for the wiring of the two departments at £145 and £115 10s., respectively, accepted.

Portsmouth.—The contract for the complete equipment of the Technical Schools of the Portsmouth Corporation with electrical and physical apparatus has been awarded to Mr. R. W. Paul; the price is £477.

Richmond.—At Tuesday's Council meeting the estimate of Messrs. Harrison, Coles & Co., was accepted for the erection and maintainence of electric call communication between Kew Fire Station and the members of the brigade, on the same system as that which has been in use by the Richmond Brigade for the past four years.

THE INSTITUTION OF ELECTRICAL ENGINEERS.

A GOODLY gathering of members and friends assembled at the Freemason's Tavern, on Wednesday evening, on the occasion of the annual dinner. Among the distinguished guests were Mr. Bryce, M.P., President of the Board of Trade, Sir John Pender, M.P., Sir Robert Herbert, Sir Robert Rawlinson, and others.

The speeches were, with one or two exceptions, remarkably poor, even for an Institution dinner. Here and there were bright touches which relieved the monotony of the gathering, but, taken altogether, the oratorical effects were not brilliant. Of course, an Institution dinner has a decided social value apart from the speeches that may or may not be delivered. It is perhaps the only occasion in the year when country members are able to meet their London *confrères*, and for this reason alone the dinner could be justified. Then again, a good dinner is a great leveller, and from highest to lowest there is much *esprit de corps* for the occasion.

After the usual loyal toasts, Mr. Siemens proposed the "Colonial Empire," which was responded to by Sir Saul Samuel and Sir Malcolm Fraser. Then Mr. Preece gave the toast of the "Learned and Engineering Societies." There was not much that was new in it. The speaker doubted as to whether he belonged to the learned or unlearned societies. Then he got on a little better ground by saying that the engineer was the working man—the practical man of to-day. There must have been a little surprise when Mr. Preece declared the civil engineers as his own particular profession. We really thought that if any man could be claimed as an electrical engineer it was Mr. Preece.

Sir ROBERT RAWLINSON replied on behalf of the Civils; and Dr. ARMSTRONG, replying for the Chemical Society, said that electrical engineers were working in a very narrow groove, they were too much devoted to the dynamo for electric lighting and power purposes. He considered that there was a good deal to be done on the chemical side.

Responding on behalf of the guests, Mr. BRYCE referred to the many occasions on which the Board of Trade and the Institution had worked together.

NOTES.

Important Litigation.—We are informed by the Electrical Power Storage Company, Limited, that it has commenced a suit for infringement of the well-known Swan patent, and have issued a writ for injunction against the Chloride Electrical Storage Syndicate, Limited. The other defendants are Mather and Platt, Limited, and Dr. John Hopkinson, F.R.S.

We are also informed that the Chloride Electrical Storage Syndicate, Messrs. Mather & Platt, Limited, and Dr. John Hopkinson contend that they are fully justified in making and using these cells, and that they intend to offer a most strenuous resistance to the claims made on them. We also learn that the Chloride Electrical Storage Syndicate are prepared to indemnify all persons who have purchased batteries from them or may do so.

Newspaper Prize Competitions.—Last week, at the City of London Court, the proprietors of *Science Siftings* had judgment given against them for the sum of £4 6s. and costs. The journal is in the habit of awarding prizes of a stated value to the successful persons in certain competitions. One of these prizes, a gold chain, was awarded to a printer, who was not satisfied that the article was worth the value asserted by the editor, *i.e.*, £6 6s. He called in an expert, who said the value was £2 10s. Notwithstanding the statement by the *Science Siftings* representative that the cost price had been £6 6s., which he fully believed the article was worth, the jury found that it was only worth £2, and the judge found for the plaintiff accordingly.

Royal Institution.—The Christmas course of lectures, adapted to children, at the Royal Institution, will be delivered by Prof. J. A. Fleming, F.R.S. The subject will be "The Work of an Electric Current," and the first lecture will be delivered on Thursday, December 27th, at 3 o'clock. The following is the syllabus:—

LECTURE I.—Thursday, December 27th, 1894.—THE MANUFACTURE OF AN ELECTRIC CURRENT.—How Bodies are Electrified—Two Modes of Electrification—Electric Discharge—Electric Sparks—Electrical Charges of Atoms—Chemical Production of Electric Current—The Galvanic Cell—Various Forms of simple Battery—An Electric Current from Oranges and Lemons—The Crown of Cups—Dry Batteries—The Current produced by Heat—Thermo-Electric Batteries—The Current produced by Light—Photo-Electric Cells—The Current produced by Magnetism—One Current producing Another—The Current as a Vehicle of Energy.

LECTURE II.—Saturday, December 29th, 1894.—THE CURRENT WORKING AS A CHEMIST.—The Electro-Chemical Power of the Current—Decomposition of Acidified Water—Copper and Silver Plating—The Lead Tree—The Laws of Chemical Deposition—How a Current is Measured—What is an Ampère?—Nickel and Gold Plating—The discovery of Potassium and Sodium—How Aluminium is obtained by Electricity—The Electrical Separation of Salt into an Acid and an Alkali—The Electrical production of Ozone—The Electro-Deposition of Copper and other Metals.

LECTURE III.—Tuesday, January 1st, 1895.—THE CURRENT WORKING AS A HEATER.—The Heating Power of a Current—The Laws of its Heat Production—Good and Bad Conductors—How Heat and Cold affect Conductivity—How to Boil Water by Electricity—Electrical Cooking—The Electrical Flat Iron—The Electrical Frying Pan and Oven—The Domestic Uses of the Current.

LECTURE IV.—Thursday, January 3rd, 1895.—THE CURRENT WORKING AS AN ILLUMINATOR.—The production of Electric Sparks—The duration of a Spark—A Flash of Lightning—Photographs of Lightning—The Electric Brush—Glow and Arc discharge—The Arc Lamp—The Incandescent Lamp—Various Forms of Lamps—The Miner's Safety Lamp—Micro Lamps—The Electric Lighting of Houses—Decorative Electric Lighting.

LECTURE V.—Saturday, January 5th, 1895.—THE CURRENT WORKING AS A MESSENGER.—Oersted's Discovery—How the Current affects a Magnet—The Current making a Magnet—The Electric Bell—A cheap Electric Bell—How Electric Signals are sent along a Wire—Telegraphic Instruments—The Old Needle Instrument—The Modern Telegraph—The Submarine Cable—Cable Signalling—The Mirror Galvanometer—How long it takes for the Current to get across the Atlantic—The Telephone—The Writing Telegraph—Transmission of Drawings by Electricity.

LECTURE VI.—Tuesday, January 8th, 1895.—THE CURRENT WORKING AS A POWER.—The First Electro-Motor—Electro-Magnetic Engines—What is a Dynamo?—How an Electro-Motor Works—An Electric Tramcar—Carriages driven by an Electric Current—An Electric Lift—Electric Railways—Electric Cranes and Hoists—Electric Ploughing—The Motor in the Workshops—Transmission of Power—The Current as our Universal Servant—Conclusion.

Electrical Organ.—We hear that Mr. Clarke, who is well known in the yachting world, now has on foot a scheme to place in the triforium at Westminster Abbey, at his own expense, an echo organ connected electrically with the main instrument.

Electricity in Mining.—The *Mining World*, commenting regarding the state and prospects of the Union Pioneer Gold Mining Company's mines in the Transvaal, says :—"The hope of the company lies in two directions—first, the working of the mine on the big scale it is intended to adopt, and next, the erection of Moodie's electric installation, which will not only supply motive power at a small cost, but enable the ore to be sent direct to the battery through the nearly completed New Pioneer adit. . . . . When we say that the former cost of treating the ore will be reduced by about one-half by the use of electric power, we may add that the opinion has been expressed that there will be a net profit of fully 25s. to the ton, even assuming that the ore does not improve in depth, as it is most likely to do."

Gas Engines for Electric Lighting.—A letter upon a very important subject appeared in the last issue of *Industries and Iron*, from the pen of Messrs. Crossley Brothers. While electricity is a powerful competitor of gas, the two often go hand in hand, one being made to assist in the generation of the other by gas engines supplying the motive power for working dynamos. Hereford has comparatively new gas works, and the Corporation now propose going in for electric lighting as well. Messrs. Crossley consider there is no reason why, in settling the electric lighting question, these gas works should not be looked upon as a most valuable asset :—

> The people of Hereford need not go to an electric light supply for the electric light, or to an oil engine either, with such a thing as a modern gas works at their disposal. It is not generally known that an ordinary gas engine will furnish a 16 C.P. lamp for a consumption of ordinary town's gas of 2 cubic feet per hour; but this has been proved by many users of the electric light, and we are somewhat surprised that such is not the case in Hereford.

It is stated that, at Southampton Public Library,

> The cost of gas lighting, with gas at 2s. 8d., was £23 15s. for 75 days, and to obtain the same light from the Electric Light Company at 8d. per unit would cost £48 18s., but the light as now obtained through a Crossley gas engine, making all allowance for depreciation, lamp renewals, interest, &c., costs £18 8s. 6d. for the same period, showing a net saving over gas lighting of £5, and over central station lighting of £30 for the three months. There are many similar instances.

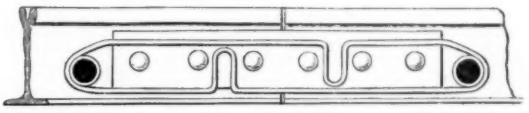
Such facts as these require no comment.

The Antwerp Exhibition.—Amongst the prizes awarded at the Antwerp Exhibition are the following :—Classes 19, 20, and 21, Metallurgy : Diplômes de Grand Prix—Felten et Guilleaume, Mulheim. Class 22, Mechanism, Heating Apparatus, &c. : Diplômes de Grand Prix—Babcock and Wilcox, Glasgow ; Galloways & Co. ; Diplômes d'Honneur—Kœrting Frères, Paris ; Tangye, Manchester ; Diplômes de Médaille d'Or—Dowson Economic Gas Company, Manchester. Class 28, Electricity and its Applications, Batteries, Dynamos, &c. : Diplômes de Grand Prix—Ateliers de Construction d'Œrlikon ; Compagnie Internationale d'Electricité (Pieper) Liège ; Felten et Guilleaume, Mulheim ; Diplômes d'Honneur—Algemeine Elektricitäts Gesellschaft, Berlin ; Jaspar, Liège ; Richard, Paris ; Diplômes de Medaille d'Or—Crompton & Co., London ; F. Henrion, Nancy. Class 29, Telegraphy and Telephony : Diplômes de Grand Prix—Bell Telephone Manufacturing Company, Brussels ; Felten & Guilleaume, Liège ; Diplômes d'Honneur—The Antwerp Telephone and Electrical Works, Antwerp ; Mildé Fils et Cie., Paris.

Electric Tramways for Hammersmith.—We learn that the Hammersmith Vestry have now given their sanction to the application recently made by the London United Tramways Company for the use of electrical power on their tramcars running in Uxbridge Road district. The overhead wire system is to be adopted ; the current will be conducted to the motor cars by means of trolley wires extended over the track by steel tube standards of light pattern, placed in the centre of the roadway, 120 feet apart, and so arranged, as to be capable of being used as electric lighting standards.

The Northern Society of Electrical Engineers.—At the Palatine Hotel, Hunt's Bank, Manchester, there will be a Smoking Concert to-night, at 8 p.m.

A Roller-Expanded Rail Bond.—Through the courtesy of Mr. Blackwell, M.I.E.E., Mr. F. Foley Robinson, A.M.I.C.E., hoped to submit a full-sized drawing of tramway rail bond (as per illustration) at last night's meeting of



the Institution of Electrical Engineers. We understand that Mr. Robinson has applied for a patent in respect of the terminals, which consist of short metal tubes expanded into the webs of rails in the usual manner employed by boilermakers to secure tubes in tube-plates. This method possesses the following advantages :—1. *Cheapness*, as ordinary wrought-iron tube may be used, sawn into short lengths, and oxide removed by grinding or otherwise. Thus no turning or expensive machining is required. 2. *Large and efficient contact area*, the surfaces of holes and tubes being quite bright. Mr. Yarrow has proved by experiment that the holding-power of a 2-inch tube, expanded in the ordinary way, is at least 8 tons, and that the effect of "rolling" is not merely to bring the two surfaces in contact, but to cause pressure one against the other.

Accident at Taunton.—A pupil, aged 17 years, met his death accidentally at the electric lighting works of the Taunton Corporation on November 6th. The youth, named Warren Upham, was seen by a labourer at about 6.45 p.m. on the day in question going towards No. 1 alternator (a 70-unit Thomson-Houston) with an oil-can to replenish the lubrication of the bearings. One minute later he was discovered leaning against the bed of the exciter and belt-guard behind, apparently dead. Medical aid was at once summoned, but it was too late. There were no marks on the body, save an abrasion on the left arm caused by the belt of the exciter as the body lay. A *post mortem* examination of the body resulted in the organs being found healthy. The doctor was of opinion that death was due to an electric shock. There was no evidence to show how the shock was received, as no one witnessed the occurrence. We are informed that the Inspector of Factories attended the adjourned inquest on the 15th inst., and expressed himself perfectly satisfied with the precautions that had been taken to guard against accidents. A local paper commenting regarding the occurrence, says :—"At the Taunton Electrical Depôt it would be difficult to provide more precautions than at present exist. It is for the assistants to make use of the precautions offered them, and there will be no danger." The jury brought in a verdict of death from an accident caused by an electric shock, and wished to add that greater care should be taken in insulating the dangerous parts of the machines, and that, if possible, a safer system of oiling should be adopted.

A Youth's Folly.—A New York contemporary states that at Utica, N.Y., on October 25th, a youth, 17 years old, was instantly killed by a shock of electricity received from the combination knob of Jeweller Bernard Goldstein's safe. Goldstein had connected the safe with the wire, furnishing a current to the motor running his lathe, as a protection against burglars. The youth and a companion were in the store examining some goods, and one dared the other to touch the knob. He touched the combination, and immediately fell dead.

The Board of Trade Conference on Light Railways.—The London Chamber of Commerce, in response to the invitation from the Board of Trade, have nominated Sir Edward H. Carbutt, Bart. (Chairman of the Engineering and Allied Trades' Section), and Mr. Emile Garcke (Chairman of the Electrical and Allied Trades' Section), as the delegates of the Chamber to the Conference on Light Railways, which is to meet early next month.

Portraiture.—With the first number of *The Tyneside*, to be published during the first week in December, is to be given as a Xmas presentation plate, an ink photo of Lord Armstrong, C.B. It is stated to be the best ever executed of him.

The Royal Society. — Before this Society yesterday afternoon the following papers were down for reading:—"A Determination of the Specific Heat of Water in Terms of the International Electric Units," by Prof. A. Schuster, F.R.S., and W. Gannon; "On the Temperature of the Carbons of the Electric Arc, with a Note on the Temperature of the Sun," by W. E. Wilson and P. L. Gray. The anniversary meeting will be held on Friday, November 30th, at 4 p.m.

Cable Communication Jubilee.—At a private dinner, on Thursday night last week, at the Hôtel Métropole, the representatives of the staff of the submarine cable companies over which Sir John Pender presides presented him with a silver trophy, or centre piece, with a desire to mark the twenty-fifth anniversary of cable communication with the Far East, and to record their admiration of his labours in the cause of submarine telegraphy. The trophy was accompanied by a silver-gilt casket containing an address.

Unsatisfactory Discussion.—Mr. Fawcus, who occupied the chair during the discussion of the Northern Society of Electrical Engineers, was evidently disappointed at the result. The low prices of work, the incompetence of the wiremen, the simple vulcanising of joints, and the peculiar action which deteriorates the insulation of conductors when attached to walls, are all points worthy of being thoroughly threshed out. But it is difficult to do this on the spur of the moment, and the columns of the electrical press are always open as a medium for settling such matters.

Electric Traction under Difficulties. — A somewhat interesting application of accumulators to traction work has been lately made in Chicago, U.S.A. The North Side Passenger Railway Company, of that city, having a franchise to construct its electric line into the heart of the city, found its work impeded by its inability to obtain the right of way for elevated conductors over about three-quarters of a mile of its route. In order to obtain the necessary supply of power over this length of track, a sufficiently powerful battery of accumulators was mounted upon a small truck. As each "trolley-car" came to the forbidden section, the storage truck was coupled to it, and towed along the line until the trolley wire was again accessible, power for the car motors being drawn from the cells. The storage truck also carries a small motor of its own, sufficiently powerful to enable it to move independently when shunting from one track to the other at each end of the section.

The Pacific Cable.—The Ottawa *Daily Citizen* for November 10th states that six definite proposals were sent in for the laying and maintenance of the proposed Pacific cable. They were from the following companies, all of London:—The Telegraph Construction and Maintenance Company, Messrs. Siemens Bros., The Fowler-Waring Cable Company, W. T. Henley's Telegraph Works Company, The India-Rubber, Gutta-Percha and Telegraph Company, and Francis A. Bowen. The offers are said to be of the most satisfactory character. They apply to each of the eight routes proposed, and in every case are below the estimates of Mr. Sanford Fleming, already made public. On the whole they are regarded as completely removing every obstacle which had been urged against the feasibility of the Pacific cable. None of them make any difference in cost of laying or working direct from Vancouver to Fiji, *viâ* Fanning Island, as against the line to Fiji, *via* Neckar Island, one of the Hawaiian group, although the latter is almost a midway station, while Fanning Island is situated at three-fourths of the distance from Vancouver to Fiji. "So that a landing at Neckar, or any other of the Hawaiian group, is in no way essential to the successful laying and economical working of the cable. And as Fanning Island is British territory, this establishes the complete feasibility of an all-British cable. It would seem, therefore, that the projectors are entirely independent of the Hawaiian Government in the matter of a landing place."

NEW COMPANIES REGISTERED.

Granada Railway Company, Limited (42,483).—This company was registered on the 16th inst. with a capital of £300,000, in £20 shares, to construct, maintain, improve, and exercise, railways, tramways, electric, pneumatic, water, or other powers, telegraph and telephone lines and works, in the kingdom of Spain or elsewhere. The subscribers (with one share each) are:—H. Barclay, Tingvith Manor, Woburn, colonel; H. G. Stephenson, 31, Lombard Street, E.C., solicitor; F. J. Irwin, St. Julian's Farm Road, S.E., merchant; B. F. Bosanquet, Enfield, colonel; J. H. W. Bary, Walton-on-Thames, gentleman; J. H. Knight, Church Hill, Loughton, clerk; H. W. Burnside, 168, Finborough Road, S.W., accountant. Until the first directors are appointed, the subscribers to the Memorandum of Association, as given above, are to exercise all the powers, and observe all the duties of directors; qualification, 25 shares; remuneration to be fixed in general meeting. Registered office, Portland House, Basinghall Street, E.C.

Leslie & Co., Limited (42,434).—This company was registered on the 13th inst. with a capital of £50,000, in £5 shares, to acquire as a going concern the businesses of builders, contractors, engineers, electric light contractors, ironmongers, &c., heretofore carried on under the respective styles of Leslie & Co., and Aldin Bros. & Davies; to enter into an agreement with this end in view, and to continue the businesses and undertakings mentioned above. The subscribers (with one share each) are:—H. Williams, 30, Great Cumberland Place, gentleman; F. E. Astley-Corbett, 57, Sloane Street, S.W., Bart.; J. H. Saunders, Prince's Club, Knightsbridge, S.W., secretary; W. J. Preston, 2, Craig's Court, Charing Cross, S.W., solicitor; H. Bundy, 54, Warwick Gardens, Kensington, gentleman; F. V. F. Howes, 193, Balham High Road, S.W., gentleman; W. F. Brown, 29, Gayhurst Road, Dalston, chartered accountant. The first directors are H. Williams, Sir F. E. Astley-Corbett, Bart., and F. Shingleton; the last named will join the board after allotment. Qualification, £500. Remuneration to be determined in general meeting. Registered by Messrs. Floodgate, Craig's Court, Charing Cross, S.W.

CITY NOTES.

The Western and Brazilian Telegraph Company, Limited.

Mr. Andrews presided at the ordinary general meeting of this company, held at Winchester House last Friday. After going through the accounts, which have been already published in this Journal, the chairman went on to speak of the remarks of Sir John Pender at the recent meeting of the Brazilian Submarine Company, to the effect that there ought to be some closer connection between the two companies. He (Mr. Andrews) considered that they were manifestly not in a position to negotiate with the Brazilian Submarine Company. It was undoubtedly the fact that the Brazilian Government had the power to purchase the Western Company's lines under the concession. There could be no question that, in addition to the desire of most Governments to acquire the sole control of the internal and some of the international telegraphs of the country, as essential to the good government of the country and the welfare of the people, the Brazilian Government had special reasons for contemplating the acquisition of this company's system. The great increase in the telegraphic service during the past four years, the report continued, pointed clearly to the purchase of the company's undertaking as an economic measure. The Western Company connected together nearly all the chief ports and centres of Brazil by its coast cables, and consequently competed with the Government in the performance of the internal message service of the country. It was most gratifying to the board that the Government had seen reason to feel that they could rely upon "the greatest loyalty on the part of the company," but still, *qua* Brazil, theirs was a foreign company, and although its complete arrangements had proved at a great crisis to be all that could be desired or expected, it was perhaps all the more natural that the Government should be educated by the facts which, owing to accident in great part, had come uppermost, and should desire to become possessed of a telegraph system of proved excellence. The proposition, however, came forward, so far as the company was concerned, just as the clouds began to break. They seemed now to be at a turning point, which would probably result in a very great expansion of the commerce of Brazil. As the Government could, of course, effect considerable economies, and would be enabled to fix their own tariffs and collections, there was no doubt that the pur-

chase, as a mere matter of business calculation, gave to the Government the certainty, if they pleased, of large financial advantage. At present they were merely in the preliminary stages of the project, as the report had to be submitted to the Chambers for their consideration. It was easy enough to accept the principle of purchase, but not so simple to arrive at conclusions satisfactory to the parties, especially in a complicated case like theirs. Nothing but terms satisfactory to the shareholders, including all equitable provisions and compensations, ought to be proposed or could be accepted.

City of London and Brush Provincial Electric Lighting Company, Limited.

The first annual general meeting was held last Monday at Cannon Street Hotel, the Right Hon. D. R. Plunket, Q.C., M.P., presiding.

Mr. B. Broadhurst (the Secretary), having read the advertisement convening the meeting,

The Chairman moved the adoption of the report. Speaking on behalf of himself and his brother directors, he thought he might congratulate the shareholders upon their present position, and also upon their hopeful prospects for the near future. It was only six months since the reconstruction and capitalisation of the company enabled them to get to work. Already the progress within the County of London was very satisfactory, and their experience outside the county in the more distant districts where they were operating had been satisfactory even beyond their most sanguine expectations. While in the county, the contracts which were spoken of in the prospectus as having been entered into between that company and the Brush Company and the Electrical Construction Company, respectively, were in course of being carried out, they might also hope before that time next year that they would have a plant capacity for serving about 90,000 glow lamps. They had also been fortunate enough to secure two admirable sites on which to erect generating stations. The one for the north side of London was situated on the Regent's Canal basin, and that for the South of London on the banks of the Thames, near their Wandsworth district. They would, therefore, at both their stations, secure the economy of water carriage for their coals, besides obtaining an abundant supply of water for all other purposes. At the same time, they had entered into contracts, which they believed to be fair and favourable, for the street works which would be necessary, and it was their intention not only to lay down a sufficient amount of conductors for their immediate requirements, but also to lay a considerable additional number of pipes into which cables might be drawn hereafter, when, as they expected, the necessity for such additional supply would arise. He believed from the number of applications they had already received, and also from observing what had happened in somewhat analogous cases elsewhere, that they would obtain very large and increasing orders both in those districts of the metropolis which they at present occupied, and in other places that they might hope to acquire later on. They were, therefore, laying the foundations of the company broad and strong, in order that they might hereafter be in a position to do a great and flourishing business, which he believed would give mutual satisfaction to the shareholders and to their customers. Turning to their operations outside the County of London, their position was no less satisfactory and encouraging. At Bournemouth, where last spring they acquired a controlling interest in the Bournemouth and District Electric Supply Company, their progress had been very rapid, and they had been obliged to enlarge their station and also to purchase additional plant capacity for the service of some 9,000 lights of 8 candle-power each. They had also made considerable additions to their mains, involving considerable expenditure, the present total capital outlay of the Bournemouth Company amounting to about £65,000. Between January and October 1st they had added some 3,000 lights to the system as it was before they took it over, and there were still a good many orders which still remained to be dealt with. Their zealous manager, Mr. Lawson, had estimated that by the end of the year the additional lamps connected with their mains should amount to about 5,000, which would make a total of 19,500 lights, as against 14,500 in 1893. By making certain changes in the plant and the station at Bournemouth, they had been able to introduce considerable economies, at the same time that they increased the efficiency of the station, and whereas the station and distribution charges last year were 6d. per unit, for this year they would amount to something less than 5d., and it was calculated that the revenue would amount to about £7,000, as against £5,000 in 1893. Their prospects at Dover, too, were extremely hopeful. They hoped they would be able to supply customers with current before next month, and they had entered into contracts with the Dover Corporation for lighting the streets and the sea front, and already 500 lamps had been wired in the Town Hall. At the same time they had offered their services to the military authorities, and he was glad to say that they had succeeded in getting an order for the lighting of the camp tower on the pier. At Windermere they had entered upon what was an interesting, and what they believed would turn out a very profitable enterprise, for they had secured there the rush of the water of the river Leven at the outlet of the lake, and it was their intention to apply that great and economical source of power to the electric lighting of those townships in the neighbourhood who might feel disposed to avail themselves of the company's services. They had made applications, and would continue to do so, for provisional orders in various other places where they thought successful business might result, and on the other hand various applications had been made to them for technical assistance by local authorities who were interested in the matter of electric lighting. Some of those offers they had had to refuse, because the expectations held out were not sufficiently encouraging, but in others the question was still under consideration. On the whole he thought they might well claim that the progress of the company up to the present time had been remarkably rapid, and that the position was one with which they might well be satisfied. It was only a short time since they commenced operations, and the policy of the board was contained in the old saying, "It is better to be sure than sorry." The company was, in a certain sense, the younger sister of the City of London Electric Lighting Company, not only in that they were both brought into the world under the same auspices, but they also had the great advantage that Mr. Braithwaite, their deputy-chairman, and Mr. Reynolds, were members of the board of both corporations. It was their desire to emulate the sound management which had produced such successful results in the City of London Company, and it was their hope that they might ultimately equal, even if they did not exceed, their success in the wider fields in which they were destined to operate. In concluding, the chairman expressed the belief that when the directors met the shareholders next spring, they would have a satisfactory account of their stewardship to present.

Mr. Alfred Thompson, a shareholder, seconded the motion, which was carried unanimously, and a vote of thanks to the chairman and directors closed the meeting.

The Royal Electric Company of Montreal.

We understand that Messrs. Coates, Sons & Co. are authorised to receive subscriptions at par for £120,000 4½ per cent. 20-year first mortgage debentures of this company. The enterprise was incorporated in 1884, under Royal Charter, with an authorised capital of $1,500,000, of which $1,000,000 is paid up, and upon which quarterly dividends at the rate of 8 per cent. per annum have, it is stated, been regularly paid for some time past. The company has, the prospectus states, important franchises and valuable contracts with the Montreal Corporation for lighting, and the net revenue from these contracts alone is said to be more than sufficient to provide for the interest of the debentures. It is stated, too, that, apart altogether from this contract, the net revenue of the company from other sources is more than is required for both interest and redemption charges. The debentures will be a first and preferential charge upon the immovable property, machinery, and plant of the company, subject to certain small charges maturing in 1895, 1896, and 1897. A reserve fund has been accumulated of $302,449, which is stated to more than cover the cost of the company's patents. The debentures are redeemable by annual drawings at 105, and the interest will be payable on April 1st and October 1st in each year. The lists were to be closed on or before (to-day) the 23rd inst.

General Electric Power and Traction Company, Limited.

An extraordinary general meeting of this company was held at Cannon Street Hotel, on Wednesday, for the purpose of considering the voluntary winding-up of the company.

Lord Egerton of Tatton, who presided, said that it was stated at the last meeting that, in view of the large loss of capital, some reorganisation of the company was necessary. The directors had proceeded with the realisation of the company's assets as far as they could. The manufacturing department had been transferred to the Acme & Immisch Electric Works, in consideration of £12,500 in fully paid shares of the company, and the electric launch business had been taken over by the Immisch Electric Launch Company, in consideration of £8,965 in fully paid shares. In the opinion of the board, the further realisation of the assets could be best carried out under voluntary liquidation.

After some further discussion, the resolution was passed *nem. con.*

The English Electric Manufacturing Company, Limited.—At an extraordinary general meeting of this company, held at Waterloo Hall, Leicester, on October 22nd, the following special resolution was passed; and at a subsequent meeting, on November 7th, the following special resolution was duly confirmed: "That the company be wound up voluntarily under the provisions of the Companies Acts, 1862 to 1867; and that Charles Frederick McInnes, of Leicester aforesaid, the secretary and manager of the company, be, and is hereby appointed, liquidator for the purposes of such winding up."

Victoria Electric Railway and Lighting Company.—The numbers are published of the 5 per cent. 1st mortgage debenture bonds, amounting to 1,000, which have been drawn for repayment on and after January 2nd, 1895, at the rate of £105 per cent., in accordance with the provisions of the trust deed.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending November 18th, 1894, amounted to £972; week ending November 12th, 1893, £882; increase, £90; total receipts for half-year, 1894, £17,091; corresponding period, 1893, £16,473; increase, £1,218.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending November 18th, 1894, amounted to £881; corresponding week last year, £553.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending November 16th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,181.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation November 14th.	Closing Quotation, November 21st.	Business done during week ended November 21st, 1894. Highest.	Lowest.
173,400*l*	African Direct Teleg., Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	103	...
1,012,880*l*	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	35 — 37	38 — 39	38½	35½
2,993,560*l*	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	70 — 71	72 — 73	73	70¼
2,993,560*l*	Do. do. Defd.	Stock	...	...	...	6¼— 6⅜	6½— 7	6⅜	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6½% §	6½% §	11¼— 11⅝	11 — 11½	11⅜	11¼
75,000*l*	Do. do. 5 %, repayable June 1906	100	...	...	...	110 —114	110 —114	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	135 —145	135 —145	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½% §	2 % §	2 % §	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13¼	12½— 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4¼— 4⅜	4¼— 4⅜	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼— 9⅜	9¼— 9⅜	...	...
30,000*l*	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	2⅝% §	8 — 8½	8¼— 8⅜	8⅜	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½% §	15⅝— 15⅞	15⅝— 16	15⅝	15⅝
70,000	Do. 6 % Pref.	10	6 % §	6 % §	6 % §	16½— 17	16½— 17	16⅜	16½
102,100*l*	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —110	106 —110	...	...
1,297,837*l*	Do. 4 % Mort. Deb.	Stock	...	...	...	117 —120 xd	117 —120 xd	119	118½
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	15⅞— 16⅛	15⅞— 16⅛	16⅛	15 15/16
54,100*l*	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —106	103 —107	...	...
194,300*l*	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	103 —106	104 —107	...	...
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	116 —120	116 —120	120	...
95,100*l*	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —106	103 —107	105½	105
129,100*l*	Do. do. to bearer, 2,344 to 5,500	...	...	...	...	103 —106	104 —107	...	...
300,000*l*	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	104 —107	104 —107	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	107 —110%	107—110% xd	109½	...
180,227	Globe Telegraph and Trust, Ltd.	10	5½% §	4⅝% §	4⅝% §	8⅝— 8⅞	8⅜— 9	9	8⅜
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15½— 16	15⅝— 16⅛	16⅛	15⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜% §	20½— 21½	20½— 21½	21 1/16	21
190,000*l*	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	106	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	46 — 48	46 — 48	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000*l*	Do. do. 6 % Debs.	100	...	...	...	104 —107	102 —106	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼— ⅜	¼— ⅜	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1 — 2 xd	1 — 2 xd	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	5 % §	4⅞— 5⅛	4⅞— 5⅛	5 1/16	4 15/16
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 16	15 — 16	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	14½— 15½	15 — 16	14 15/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5½— 5⅝	5⅝— 5⅞	5¾	5⅝
1,000,000*l*	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	110 —113	110 —113	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	7/16— 9/16	7/16— 9/16	...	...
100,000*l*	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	104 —107	104 —107	105	...
11,839	Reuter's Ltd.	8	5 %	5 %	0 %	3 — 5	3 — 5	3⅜	3
3,381	Submarine Cables Trust	Cert.	...	...	...	103 —108	103 —108	...	...
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2 — 3	2 — 3	...	...
146,733*l*	Do. do. 5 % Debs.	Stock	...	...	...	88 — 94	88 — 94	91	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	0 %	3 — 5	3 — 5	...	...
249,900*l*	Do. do. do. 5 % Debs.	100	...	...	...	100 —103	100 —103	102⅜	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	2	...
150,000*l*	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	101 —106	100 —105	104	...
64,242	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	2½%	10 — 10½	10 — 10½	10½	10¼
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6¼— 6⅜	6½— 7	6⅜	6⅜
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	4¼— 4⅜	4¼— 4⅜	4⅜	4¼
171,900*l*	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	103 —106	101 —105	...	...
214,800*l*	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	103 —106	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1¼	1 — 1¼	1⅛	1 1/16
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	11 — 11½	11 — 11½	11⅜	11½
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	...	9 — 10	9 — 10	...	...
80,000*l*	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	108 —111	108 —111	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	112 —118	112 —118	...	...
166,900*l*	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply, 1 to 6, 215 to 718, and 10,001 to 30,000	5	...	5 %	4½%	4½— 5⅛	4½— 5⅛	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	12 — 13	12½— 13½	13¼	12⅝
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14⅜— 15½	14⅜— 15½	15½	14⅜
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	131 —133	131 —133	133	...
50,000	†Liverpool Electric Supply, all paid	5	4½%	5 %	5 %	6⅝— 6¾	7 1/16— 7 3/16	7 1/16	...
49,900	*Metropolitan Electric Supply, Ltd., 6,101 to 50,000 ...	10	1 %	2 %	2½%	9¼— 9⅜	9¼— 9⅜	9⅜	9 5/16
100,000*l*	Do. 5% Deb., 1 to 10,000 in bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	6½— 7½	6½— 7½	7 1/16	7
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7¼%	4½%	7½— 8	7½— 8	7⅝	7 1/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¾— 9¼	8¼— 9	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	7 — 7½	7 — 7½	7 1/16	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, Nov. 14th.	Closing Quotation, Nov. 21st.	Business done during week ended Nov. 21st, 1894. Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅛ — 2⅜	2¼ — 2⅛	2⅛	2⅜
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2¼ — 2⅛	2¼ — 2⅛	2 7/16	2¼
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	110 —113	110 —113	112¼	110½
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	37 — 39	39 — 41	40⅜	40½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2½ — 3	2¾ — 3¼	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	95 —100	95 —100	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	⅜ — ⅝	⅜ — ⅝	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 2	1½ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	¼ — ¼	¼ — ¼	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1⅝ — 1⅝	1⅝ — 1⅝	1 9/16	1 7/16
67,385	Elmore's Wire Mfg., Ltd., 1 to 67,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	1¼ — 1⅜	1¼ — 1⅜	1 3/16	1⅛
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	8 — 9	8 — 9	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	25 — 26	25 — 26	25⅝	25¼
200,000	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	7 15/16 — 8 1/16	7 15/16 — 8 1/16	8⅛	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	13 — 13¼	13 — 13¼	...	...
	Swan United Electric Light, Ltd.	...	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	41 — 43	41 — 43	43	42½
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2⅛ — 2⅜	2⅛ — 2⅜	2⅜	2¼

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%§; 1891—7%§; 1890—8%§.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5¾—6.
Electric Construction Corporation, 6 % Debentures, 87—92.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
House-to-House Company (£5 paid), 2⅛—2¼.
Do. do. 7 % Preference, of £5, 6⅛—6⅜.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4¾—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅜.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
London Electric Supply Corporation, £5 Ordinary, ⅞—1⅛.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4¾.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

ELECTROLYSIS IN URETHRAL STRICTURE: A RÉSUMÉ OF STATISTICS AND ARMANENTARIUM.

By ROBERT NEWMAN, M.D., New York,

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Electrolysis in the treatment of urethral strictures has been practised by me with success for over a quarter of a century.

To convince the profession of the correctness of my assertions, I will try as briefly as possible to show the following points:—

1. That the theory of electrolysis is based on sound scientific principles.
2. That the correctness of such principles will be confirmed by practical experiments.
3. That both theory and practice have been applied on patients with good results.
4. The statistics of 1,755 successful cases (*Times and Register*, April 8th, 1893), by 54 different operators.
5. Documentary evidence proving the foregoing.
6. Proof of the correctness of the documentary evidence by the report of the investigating committee.

Next, the instruments devised expressly for these operations will be demonstrated, with the *modus operandi*, rules to be observed in order to avoid failures, concluding with the advantages of electrolysis over other methods.

I.—The Theory of Electrolysis.

The treatment of strictures depends, among other factors, chiefly upon the action of the electricity in causing "galvano-chemical absorption." This absorption is the process or act of being made passively to disappear in some other substance, through molecular or other invisible means, as the absorption of light, heat, electricity, &c. *Electrolysis* is the decomposition of a compound body by electricity—a chemical decomposition. The body to be decomposed must possess certain elements to be an electrolyte, and, as a compound body, must contain water and a salt. A simple element cannot be further subdivided, and therefore cannot be an electrolyte. Tissues of the human body have all the properties of an electrolyte, and therefore electrolysis can be applied there, and it has a chemical action is an undisputed fact.

Nicholson and Carlisle discovered this process of electrical decomposition in 1800, and successfully electrolysed water into oxygen and hydrogen; therefore the theory is not new, and the explanation can be found in any text-book on elementary physics and chemistry. In combination with this chemical action is the cataphoric, which, by some authors, is considered an important factor in electrolysis. The explanation lies in the direction of the current interpolar, between the elements from zinc to carbon, or the current from electro-negative to the electro-positive. In the external current between anode and cathode, the direction of the current is opposite, and the particles of the fluid gather at the electro-negative pole, which is the cathode. The galvanic current only produces the desired result.

II.—Correctness of the Theory Explained by Experiments. Action of the Poles—Tests for the Identity of each Pole.

1. *Water Test.*—The simplest and best method is to immerse two electrodes in the form of platinum needles in water, and it will be seen that hydrogen at the negative pole shows itself in distinct bubbles, like pearls, around and above the needle, sparkling almost like carbonic acid in an effervescent.

2. *Meat Test.*—The poles of the battery, in the shape of two needles, platinum is best, are inserted in a piece of fresh raw meat. After electrolytic action has been allowed to take place for a while, the difference in pole action can readily be seen. The positive pole almost destroys it; at the negative pole the colour is nearly white, and bubbles of hydrogen appear. In electrolysis the action of the poles is very different, each having its own function. The positive pole attracts the acids and the oxygen from the tissues, and coagulates blood. The negative pole attracts the alkalies, hydrogen, and the base of the salt, dissolves blood, but forms a plug from froth of the hydrogen, coagulates albumen, and causes absorption. The positive pole acts like an acid, and burns like fire, which is not only exceedingly painful, but may leave a hard resilient cicatrix. The negative pole acts more like a caustic alkali, which should not hurt so severely during the application, and leaves, if carried to excess, a cicatrix which is soft and not retractile.

Thus it is evident that, for the immediate destruction of tumours and for the treatment of strictures, the negative pole should be selected. Electrolysis requires the presence of water, and that is what we find in every tissue of the human body.

It is vitally important to distinguish the poles, and, as we cannot trust to the marks of the instrument maker, we must always ascertain which is the positive and which is the negative pole. The positive pole is noiseless; the litmus paper applied to it shows an acid reaction, and the needle adheres firmly to its surroundings in the meat; the needle of the negative pole sticks loosely in the meat, can easily be removed, and during electrolysis a hissing sound proceeds from it.

A piece of fresh meat still contains water enough to be an electrolyte, while the living body, in which the circulation is active, is better; a dried-up piece of meat is not an electrolyte.

3. *Decomposition of a Salt.*—If, for instance, a solution of iodide of potassium be subjected to electrolysis, one equivalent of hydrate of potassium is liberated at the negative pole, showing that the potassium liberated from combination with the iodine has united with some of the surrounding water. This can be illustrated by simply holding both poles in the solution while the galvanic battery is in action.

The following experiment, however, is more strikingly demonstrative, and is believed to be original with the author. Two small glass vials are filled with a solution of iodide of potassium. For the bottoms of the vials a piece of pig's bladder is substituted: the necks are then stopped by a cork, through which runs a platinum wire, one end of which is immersed in the solution, and the other attached to a pole of the galvanic battery. Both vials, so closed, are now placed in a dish of water; they are 6 inches apart from each other. There is no communication between them except the water, and so long as the battery is at zero, there is no change in the solution, which is transparent and undisturbed. As soon as the battery begins to act the change is visible. Begin with only six cells, and you will notice, almost immediately, in the vial connected with the positive pole, that in the clear solution streaks of yellow appear, and in about 5 minutes the vial will contain only a dark yellow fluid, which is the iodine set free at this pole. At the negative pole the contents of the vial remains clear, only bubbles of froth welling up. This is the hydrogen set free from the water. The result of this electrolysis is iodine, oxygen, and hydriodic acid at the positive pole, while at the negative pole we find hydrogen and potassium.

If this experiment is tried with a faradic battery, as has been often verified, no change whatever takes place in the solution. This is another proof that the action of the galvanic current is widely different from that of the faradic, and that for electrolysis a galvanic current only can be used.

More tests can be made by the galvanoscope (milliampèremeter), Oersted's method, &c.

III.—Theory and Practice has been Proved by

1. The success of the operation, the evidence of the patients, the concurrent opinion of their family physicians, either by witnessing the operation or examining the patients before and after the operation by the final results, no relapses having occurred after patients having been discharged as cured, some patients having been under observation and examination for eleven years.

2. By the success of many other operators, as well as by converts who succeeded after previous failures, and last, by the literature on the subject of authors and editors in journals and modern text-books.

IV. Statistics of 1,755 successful cases, of which the author has contributed 300, as published in the *Times and Register*, Philadelphia, April 8th, 1893. Every case is vouched for by the respected operator, and the references given.

V.—Documentary evidence for everything stated has never been concealed from those desiring an honest examination, and is always open to inspection, as can be substantiated by reference to most of the patients themselves, or to their family physicians or friends. These documents consist either of reliable publications in medical journals, or of letters addressed to the author, which are all preserved in their original.

VI.—Correctness of Documentary Evidence.

The author's attention was brought to the fact that Dr. Keys, as editor of the "Annual of the Universal Medical Science," 1890, "Genito-Urinary Surgery," Vol. III., Section E, pages 15 and 16, has doubted the correctness of Dr. Sanders's letter. That letter was written and published in 1885. With apparent designs, after the death of this physician and a lapse of about four years from the date of the letter, Dr. Keys wrote a polite note to that physician. This polite note, as should be expected, was as politely returned by the postmaster, who evidently declined to assume the responsibility of forwarding it to its destination, and the critical investigator closed his report with the triumphant words, "If the testimony of all the letters in support of electrolysis is no more accurate than that furnished by the letter of F. F. Sanders, it is poor indeed. The inference is obvious, &c."

In answer, I am pleased to say I can produce the original letter of Dr. Sanders, attached to a sworn affidavit acknowledging its genuineness and Dr. Sanders's handwriting. The affidavit is subscribed by a notary public, and his standing as such and the signature certified by the county clerk, who has affixed his official seal. Next, I have a letter from the sister of the deceased, who also acknowledges Dr. Sanders's writing and recollects the case. And last, I received a letter from the secretary of the Medical Society of Morris County, N.J., saying that Dr. Sanders was well known in Morris County, was one of the founders of the said society, and in 1885 was elected an honorary member.

All the letters quoted are original in my possession as documentary evidence, but it is impossible to show the same to every member of the medical profession in the United States, neither can I have every one certified by notary publics and county clerks. However, the matter has been finally settled by the report of a committee who has investigated my statistics and documents very carefully, taking almost one year's time to do so.

At the annual meeting of the American Electro-Therpeutic Association held in Chicago, the committee, "on investigation of Dr. Newman's statistics of urethral strictures," reported on September 12th, 1893, that they had made a very careful and conscientious examination of Dr. Newman's records and statistics, and had asked, but unsuccessfully, for the co-operation of certain general surgeons. The committee unanimously agreed that Dr. Newman's statistics fully substantiated the claims he had made. The report is signed Drs. A. H. Goelet, Wm. J. Morton, W. J. Herdman. *Journal* American Medical Association, December 9th, 1893, page 906; *Times and Register*, November 11th, 1893, page 1,010, &c.

Stricture of the Male Urethra.

Definition.—Stricture is a pathological condition of the urethra, structural change of the tissues, narrowing permanently the calibre of the urethral canal. This is a progressive change.

Text-books describe different kinds and forms of strictures, which have no significance for our purpose.

The so-called spasmodic stricture is here excluded, because: First, it is a misnomer, as a spasm can cause only a temporary obstruction, not a stricture; therefore it is unscientific and misleading. Second, the galvanic current never cures spasmodic action. On the contrary, it will aggravate and make the obstruction worse. It shows ignorance when some medical men insinuate that strictures reported cured by electrolysis were only spasmodic strictures; but it is a fact that spasm of the bladder and urethra will yield to the faradic current. "The spasmodic stricture" should be expunged from the nomenclature of strictures.

Diagnosis.—It also has been hinted that in the tabulated statistics some errors in the diagnosis may have been made. To answer such insinuations, I have to say that I scarcely had anything to do with *making* a diagnosis, and only had to verify those already made by the best acknowledged talent of genito-urinary fame.

Most cases had been treated before for stricture, some had been operated on, the diagnosis had been made, and after many failures of other methods, were sent to me to be treated by electrolysis. The tabular statistics published show that cases were cured by electrolysis after other means had failed.

Examination of the stricture is made, first, by instrumental manipulation and the touch, by exact measurement and by ocular inspection.

Instruments.—A complete armanentarium for the treatment of urethral strictures by electrolysis consists of the following instruments which are made by the Waite, Bartlett Manufacturing Company, Geo. Tiemann & Co., Henry E. Stammers, of New York, and others.

A galvanic battery with conducting cords, one or two handles, electrodes, best of carbon and covered, two or three binding screws (fig. 2), one milliampèremeter, filiform guides (fig. 6), bougies à boule (fig. 5), four sets Newman's electrodes, added, may be a good rheostat, which is very convenient, but not absolutely necessary.

An acid battery of about 20 cells, with elements of carbon and zinc, will do best for the beginner if portability and cheapness is desired, otherwise a good stationary cabinet battery is recommended as a convenience and an ornament to the office.

A milliampèremeter to measure the current correctly is, now-a-days, an absolute necessity. The bougie à boule, fig. 5, is the best exploring instrument. This instrument is made of whalebone, has a small olive-shaped head and slender neck, which adds to its flexibility. It is used to explore the urethra and find the number, nature, and size of the stricture—the real topography.

Filiform guides, fig, 6, are used to prevent false passages; the tunnelled electrodes run over these guides with perfect safety.

Newman's urethral electrodes consist of four separate sets, as follows:—1. The egg-shaped set, fig. 1. The regular electrodes for all

Fig. 1.—The Egg-Shaped Electrode.

ordinary cases have a short curve, an egg-shaped metallic bulb at the working end, while at the upper end there is a round wire rod for the binding screw of the negative pole of the battery; the only points not insulated and acting as conductors are these extremities. The rest of the electrode must be well insulated, smooth, and without inequalities; a conical bulb is objectionable, as we depend on the electrolytic power of absorption, not on force. The length of the bulb is proportioned to the size of the electrode; thus for No. 11 French it is $\frac{3}{16}$-inch, while for No. 21 it is $\frac{5}{8}$-inch. The set consists of Nos. 11, 14, 17, 18, 20, 21, 23, 25, 28 and 30 of the French scale.

2. The acorn set, fig. 2. These are for use in the first 6 inches of

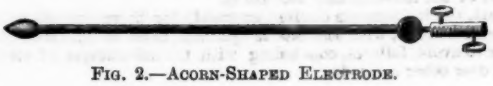

Fig. 2.—Acorn-Shaped Electrode.

the urethra in certain cases, and consists of Nos. 15, 17, 20, 22, 25, 27 French. They are without a curve, short, and the bulb is acorn-shaped. Sometimes it is desirable to gain ground by entering the contraction first with the point of the electrode, in order to follow more easily with the larger part of the acorn; then this form will do good work. The action of the electrolysis depends on the largest diameter of the bulb in these cases, and does most service on the withdrawal of the electrode, when the operator feels best how much work should be done. It is also used when the stricture is near the meatus. It can be ordered in any size.

3. The tunnelled electrode, fig. 3. These are Nos. 9, 11, 14, 17, 20 and 21 French. They are important for bad tortuous strictures, and are to be used only by the expert operator. The curve is shorter, and the egg-shaped bulb tunnelled so that it may be introduced easier

over a filiform guide, fig. 6. They are on the principle of the tunnelled sound, invented by Dr. J. W. S. Gouley, and that principle was applied by the author to his electrodes, so that electrolysis and tunnelled sounds could be used simultaneously. Where the stricture

Fig. 3.—The Tunnelled Electrode.

was impossable with ordinary instruments, this was used successfully, and passed through the stricture without the possibility of making a false passage.

Fig. 4.—The Combination Electrode, Combining Tunnelled Electrode and Catheter.

4. The combination electrode, fig. 5. This is a tunnelled electrode for extreme cases. Where a very tight stricture is complicated with retention of urine, the indications are to remove the obstruction and draw off the water with one instrument, as the parts are too sensitive to tolerate the introduction of two instruments in succession. Also,

Fig. 5.—Bougie a Boule.

Fig. 6.—Filiform Guide.

the patient may be benefited by washing out the bladder, all of which can be done with *one* introduction of the instrument. The beginner may buy just such instruments and sizes as he needs, and add to them as necessity requires, while the busy specialist may want more sizes than specified above.

Modus Operandi.

The diagnosis having been made, the stricture examined and measured with the bougie à boule as explained, the history taken, and the topography of the uretha well ascertained, and a plan made for the treatment and operation, a full knowledge is attained of what is intended to be accomplished. It is not advisable to operate on the same day; it is better to have one day intervene between preliminary examination and the operation. Genito-urinary surgery is generally applied too severely, and often causes new inflammation, instead of allaying it.

When all preliminary arrangements have been made, the electrode is selected and lubricated with a conducting fluid, then introduced into the urethra till the bulb is arrested by the stricture. It is also well if, on the stem of the electrode, a mark has been made to indicate the distance of the stricture from the meatus; thereby to make certain when the bulb end has reached the beginning of the stricture, according to measurements previously made. A sponge electrode, wet with hot or salt water and connected with the positive pole of the battery, is to be held firmly against the patient's skin, either in the palm of the hand or pressed against the abdomen, the thigh, or some other part, to complete the circuit. At this stage of the procedure, it is well to observe that the positive pole touches only the cuticle of the patient and not any metal. While both poles are held in this manner, the current should be increased from zero very slowly and gradually, until the patient feels a warm and slightly pricking sensation. This increase is made slowly, by one cell at a time, or gradually by the rheostat. At the same time the current is measured by the milliampèremeter; as a rule the current ought not to be stronger than 5 milliampères, and in many cases three or four will suffice.

The operator must keep the bougie steady against the stricture, and he will soon find that absorption is taking place, that the stricture yields, enlarges, and the instrument slowly advances and passes the obstruction. At times it will fairly jump through the stricture. If there are more strictures than one, the bougie should be guided in the same way until it enters the bladder. Then the electrode is to be withdrawn slowly, and each stricture well worked out until the first stricture is repassed, when the current is again to be reduced slowly, cell by cell, to zero; and then, and not till then, is the electrode to be removed. During the whole operation the electrode must be held loosely and gently in its place against the obstruction, all pressure or force being avoided. The bougie will take care of itself, doing its work by the electrolytic action of the current.

Rules.

Recapitulation as a safe guide for the treatment of electrolysis in stricture of the urethra:—

1. Any good galvanic battery will do which has small elements and is steady in its action; the 20-cell battery, with zinc and carbon elements, is an excellent instrument, and sufficient for the beginner.
2. The fluid for the battery ought not to be used too strong.
3. Auxiliary instruments are important to the expert, but not necessary for the beginner. However, a milliampèremeter, to measure the current, is now imperative, and a good rheostat desirable.
4. For the positive pole a carbon electrode is used, covered with sponge or absorbent cotton, moistened with hot water, and held firmly against the cutaneous surface of the patient's hand, thigh, or abdomen.
5. For the absorption of the stricture the negative pole must be used.
6. Electrode bougies are firm sounds, insulated with a mass of hard-baked rubber. The extremity is a bulb, which is the acting part in contact with the stricture. Four varieties are now in use.
7. The curve of the electrode should be short; large curves are mistakes.
8. The plates must be immersed in the fluid before the electrodes are placed on the patient, and raised again after the electrodes have been removed, if a portable battery is used.
9. All operations must begin and end while the battery is at zero, increasing and decreasing the current slowly and gradually, avoiding any shock to the patient.
10. Before operation, the susceptibility of the patient to the current should be ascertained.
11. The problem is to be absorb the stricture, not to cauterise, burn or destroy tissues.
12. Weak currents, at long intervals.
13. In most cases a current of six cells, or from 2½ to 5 milliampères, will do the work, but it must be regulated according to the work to be done.
14. The séances should be at intervals, not too frequent in succession, about once a week on an average, and each lasting from five to 20 minutes.
15. The best position for the patient to assume during the operation is that which is most comfortable to himself and to the operator. The author prefers the erect position, although the recumbent or others may be used.
16. Anæsthetics ought to be avoided, the patient is in the best condition when conscious, so that he may tell how he feels. Sometimes, and exceptionally, cocaine may be used.
17. Force should never be used, the bougie must be guided in the most gentle way; the electricity alone must be allowed to do the work. Avoid causing hemorrhage; if hemorrhage is present, do not operate.
18. During the séance only one electrode should be used. It is never safe to introduce two instruments in succession.
19. All strictures are amenable to treatment by electrolysis.
20. Pain should never be inflicted by the use of electrolysis; therefore it should not be applied when the urethra is in an acute or even sub-acute inflammatory condition.
21. The electrodes should not be greased with substances which are non-conductors and would insulate.
22. For ordinary strictures, the size of the bougie selected should be three numbers (French) larger than the stricture.

Failures.

If the rules of treatment, as described above, are carefully carried out by the operator as well as by his patient, there ought to be no failures, or, at least, they will be very rare. It is, however, an undeniable fact that failures have been reported, even by excellent medical practitioners. The cause of such failures, in most instances, could be traced to bad management, in which all rules of physical laws and surgical dexterity were ignored. In brief, the cause of such failures depends on—

1. The operator; his incompetency, carelessness, want of patience, mismanagement of the case, or a wrong diagnosis.
2. Faulty instruments.
3. The patient himself, in not following orders, or being tampered with.

These include almost all causes of failures, some or all of which have been mentioned in other chapters.

Relapses.

One of the advantages of this operation is that when a stricture is cured, as a rule, no relapse takes place. Many reports by different operators have confirmed this statement. These statistics have been explained.

It is safe to state that relapses will not occur when the patient has been dismissed as cured.

The conditions are that the strictures must be treated until they are cured by having assumed healthy tissues, all the fibrinous, cartilaginous, and cicatricial encroachments entirely removed, and the size of the calibre sufficiently enlarged. It is not necessary that the calibre be enlarged to theoretical fancy numbers, and not even to its normal size; but to such a calibre that the patient can confortably micturate, and that the bladder is not forced to extra exertions and painful contractions, in order to relieve itself of the water, which must be expelled for its comfort and rest. This is generally accomplished after an electrode of No. 25 or 28 French scale has passed easily, but exceptionally some patients may be declared well after the passage of a No. 23, and other patients need a larger calibre, until they can be dismissed as cured. As many patients absent themselves after an improvement, when they feel comfortable, and without being cured, it is a natural consequence that the stricture will close up again, and such patients return reporting "worse," or go to another practitioner, telling him the electrolysis treatment was followed by a relapse. While such cases have been observed, they cannot be called true relapses.

The Advantage of Electrolysis.

1. Electrolysis is applicable to all strictures in all parts of the urethra.
2. It will pass and enlarge any stricture when other instruments fail, which has often been demonstrated.

3. It causes no pain or inconvenience.
4. It is devoid of danger.
5. It is not followed by hemorrhage, fever, or any other unpleasant consequence.
6. It relieves at once.
7. The patient is not prevented from attending his daily work or business, and can earn his living while under treatment without restraint.
8. No relapse takes place, if once cured.

PROCEEDINGS OF SOCIETIES.

Physical Society.

Ordinary Meeting, November 9th, 1894.

Prof. A. W. Rucker, F.R.S., President, in the Chair.

The meeting was held in the rooms of the Chemical Society, Burlington House.

Dr. J. Larmor's paper on The Significance of Wiener's Localisation of the Photographic Action of Stationary Light Waves, was read by the Secretary, Mr. Elder.

The experiments by which Wiener demonstrated that when stationary plane-polarised optical undulations are produced in a photographic film, by reflection of a stream of plane-polarised light at a metallic or other backing, the photographic action occurs at the antinodes of Fresnel's vibration vector, and not at the nodes, have been employed by its author and others to decide between the various theories of light. Using the terminology of the electric theory of light, we may say that the photographic action takes place at the antinodes of the electric vector, which corresponds to Fresnel's vibration, and not at the intermediate antinodes of the magnetic vector, which corresponds to McCullagh's and to Neumann's vibration.

The crucial experiment of Wiener relates to the case when the angle of incidence is 45°, so that the direct and reflected waves which interfere are at right angles to each other. When the light was polarised in the plane of incidence, the photographic plate developed a series of bands; but when it was polarised in the perpendicular plane, these bands are absent.

The argument employed is, that the photographic effect will be greatest at those places in the stationary wave-train where the vibration is most intense; and the conclusion has been drawn from it that the actual vibration is represented by Fresnel's vector, and not by MacCullagh's; in other words, that the vibrations of polarised light are at right angles to the plane of polarisation. The force of this argument, as against MacCullagh's theory, would, however, be evaded if the vector of that theory were taken to represent something different from the linear displacement of the ether, or if vibrations were excited in the molecule by rotation instead of translation, or by stress.

Now there are about 10^3 molecules of the sensitive medium in the length of a single wave of light: thus in the stationary wave-train all the parts of a single molecule would at any instant be moving with a sensibly uniform velocity, which increases and diminishes periodically. It does not seem clear, however, that alternating stress might not be as potent a factor in disintegration as alternating motion.

The author proceeds to discuss the question from the point of view of an elastic-solid-ether theory, and he points out (from dimensional considerations) that even a very rare medium of very low rigidity might powerfully influence the movements of foreign bodies suspended in it, provided the linear dimensions of such bodies were sufficiently small. We may imagine a working illustration of a ponderable transparent medium of elastic-solid type as made up of very small spherical nodules of great density and rigidity, dispersed through the ether, and imbedded in it. A wave running across such a medium may excite these groups, thus illustrating selective absorption, the elasticity of the medium alone being operative, and no other internal forcive.

A theory based on difference of rigidity without difference of inertia, after MacCullagh's manner, would have to be realised by ascribing to the atom an atmosphere of intrinsic etherial strain, instead of endowing it with great inertia; and this could only be possible in a rotational ether, and would, in fact, form a mechanical representation of the electric theory. As such, it must be expected to give an account of the phenomena of electricity as well as of those of light, and in such an account is founded one of its chief claims.

The difference between the dielectric coefficients of a material medium and a vacuum is simply and naturally explained by the hypothesis that the material molecules are polar, owing to their associated atoms having equal and opposite charges. An electric force thus tends to pull the two constituents of a molecule asunder, and its full intensity is exerted in this manner, not merely its differential intensity over the range of the molecular volume. But a magnetic force would have no such tendency, even were the molecule magnetically polarised, because the two poles of a magnetic element cannot be dissociated. On the electric theory, therefore, there is abundant justification both for the magnitude of the effect produced and for its localisation as determined by Wiener. The author has endeavoured to show elsewhere that the principles of MacCullagh's theory of optics are in substantial agreement with all the general features of our electrical and optical knowledge. It is definitely implied in the electromotive, as distinguished from an electro-dynamic character of the electric theory of light, that the atomic charges vibrate in unison with the light waves, quite unimpeded by any material inertia of their atoms.

A letter was read from Prof. Lodge, criticising the manner in which Wiener's results had been summarised by Dr. Larmor; the summary at the commencement of the paper being characterised as misleading. The letter concluded with an expression of admiration for the work done by Dr. Larmor in working out electricity and optics, starting from MacCullagh's theory of light.

Dr. Stoney objected to the suggestion that atomic charges could vibrate unimpeded by material inertia. We had not merely to consider the bodily translation of a molecule, but the relative motion of its parts. Radiation absorbed by a gas acted on its atomic charges; part appearing as translational energy of the molecules, part as energy of their internal motion, and the ether acting as an equaliser of molecular energy.

Prof. Minchin did not understand why the polarised light in Wiener's crucial experiment should be incident at 45°. He also found it hard to imagine what vector other than the simple displacement of the ether could be the vector of MacCullagh's theory.

Dr. Burton said he found no difficulty in following Dr. Larmor's statement of Wiener's results; it appeared to him perfectly clear and satisfactory.

Dr. Sidney Young then read a paper on The Influence of the Relative Volumes of Liquid and Vapour on the Vapour-Pressure of a Liquid at Constant Temperature.

The author has very carefully examined the question raised by Prof. Battelli, whose researches have led him to the opinion that the vapour-pressure of a liquid at a given temperature depends on the relative volumes of liquid and vapour being higher the greater the proportion of liquid. This conclusion is entirely opposed to the results obtained by Dr. Ramsay and the author, the suggestion being that in Prof. Battelli's experiments an error arose from the presence of air or other impurity in the liquid examined, or in the employment of insufficiently purified substances for heating purposes.

In a letter published in the August number of the *Philosophical Magazine*, Prof. Battelli adheres to his conclusion, and does not admit the existence of either of the sources of error suggested. "I would rather observe," he writes, "that, in order to observe such a phenomenon, an apparatus is necessary which enables us—as in my case—slowly to compress the vapour, and to maintain it for a time under constant pressure." The author thinks it hardly necessary to point out that these conditions are fulfilled in the apparatus employed by Dr. Ramsay and himself. During the present year he has been engaged in investigating the thermal properties of isopentane, a liquid boiling at 28°, which can, by suitable treatment, be obtained in a pure state. The results, it is claimed, prove conclusively that the vapour pressures of isopentane are independent of the relative volumes of liquid and vapour. A table is given showing that (although the relative volumes of liquid and vapour vary between wide limits) there is no such corresponding variation in the vapour pressures, the greatest difference from the mean value at 140° being slightly less than 0·1 per cent., and at 90° slightly greater—in no case outside the limit of experimental error.

The Chairman remarked that, although the *à priori* considerations against Prof. Battelli's view were very great, it was satisfactory to have had the experimental enquiry carried out with such care and accuracy by Dr. Young.

Mr. Burke communicated a paper on A Suggestion of Prof. J. J. Thomson in Connection with the Luminescence of Glass due to Cathode Rays.

More than a hundred years ago Beccaria observed that when vacuum bulbs were broken in the dark, a light, consisting of a faint glow, was produced in the place where the bulb lay. Beccaria was led by his experiments to attribute this effect to the rushing of air against the glass walls of the exhausted vessel, and in his "Recent Researches in Electricity and Magnetism," Prof. J. J. Thomson indicates its possible close relationship to Mr. Crookes's theory of the luminescence of the glass in Geissler's tubes. The author, however, has made numerous experiments on the breaking of glow lamps, and on the admission of air to an exhausted chamber by the breaking of a thin plate of glass or of a piece of bladder closing an aperture in the walls. In these cases, and in other cases where it was possible for fragments of solid to be projected against the walls of the vessel, a luminous appearance was obtained; while in other cases, where such solid fragments would be absent, no luminosity was observed. The author concludes that Beccaria's phenomenon was due to the impact of glass against glass, and not to the rush of air against the walls of the broken vessel.

The Northern Society of Electrical Engineers.

Lighting Installations. By H. A. Henderson, Member.

The following discussion took place on Mr. Henderson's paper:—

Mr. Eidsforth: The point which struck me most forcibly was the system of testing joints. Of course, in installation work proper I have not had much experience, but I used to have a great deal to do in the cable line, and at that time joints were tested under water, and it seems to me to be a great mistake that this is not the case now. I don't know the system which is at present in use, but Mr. Henderson said he had tested something like 500 installations, and he seems to have got hold of a good few bad joints out of that number.

Mr. Claremont: The only thing in Mr. Henderson's paper which

has struck me is the paragraph or few words which he said about the consumer having to pay high prices for fittings unless he goes to a manufacturing firm. This should not be the case if the manufacturer is sufficiently fair to allow discount to the trade only.

Mr. H. Wooler: The only thing I have to find fault with in the paper is the remark made about Manchester being in a better position than any other town for the supply of current, having the alternative of wiring either on the three or five-wire systems. Mr. Henderson said that owing to having two or three different voltages to select from, they should be able now to supply current cheaper than anywhere else, and he mentioned the Free Trade Hall as a case in point. I very much doubt that. We all know that the higher the voltage the less the current, or should be; but in Manchester, where they have a fixed contract, and charge you for the whole of the lamps connected, and possibly you do not use half of them, it becomes rather arbitrary, and they certainly have not had a very small bill at the Free Trade Hall.

Mr. C. S. Northcote: I should like to correct Mr. Wooler in one or two of his statements. He points out that at the Free Trade Hall the charge for current is high. This is on account of their being wrongly advised. I am rather surprised that he should draw attention to the fact. The installation has never been properly metered, and furthermore, when the Manchester Corporation meter such installations more satisfactorily than they are at present, there should be less grumbling. There is nothing, in my opinion, in the paper about the saving of current to the consumer, but a suggestion as to the price of installations. I beg pardon, it is mentioned, but I should call it an error.

Mr. Wooler: The only point I can make out by using the three-wire or multiple wire system is that you can afford to put in larger cables.

Mr. Northcote: I may say that I quite agree with Mr. Henderson's remarks *re* the sub-circuit system. I myself know that very little work has been done up to the last few months on this system. When the electric light first came into use, the tree system was mostly employed, but undoubtedly that has been altered in Manchester lately; most buildings are now wired on the multiple system with sub-distribution boards for alternate circuits. I think Mr. Henderson is right in remarking that this is a good system, and should be more generally used. With regard to Mr. Claremont's suggestion as to manufacturers maintaining discounts, I think it is a very great pity that we cannot all combine together and get the prices raised, instead of cutting them down so. I have a case in point which I happen to know of, where a large manufacturer of a certain article in which we were interested and supplying to consumers, quoted us £500 for certain goods. I was asked our price, and on mentioning this, was shown a telegram from the makers direct, allowing, say, 5 per cent. off this price. Such instances as this make things very awkward sometimes.

Mr. Thomas: There is only one point in the paper which I should just like to mention, and that is the action of cement on India-rubber; it seems to have a very strange effect. For instance, if you put a wire into a bucket of water you get no leakage through it at all, but if you put that same wire upon a damp wall, whether there are any joints in it or not, you get a leakage through it after it has been up possibly only a few hours, and I never had this explained. Perhaps some of the gentlemen in the cable line will be able to assist us in this matter.

Mr. Fawcus: I have myself noticed considerable action having taken place with casing fixed against enamelled bricks, and there can be nothing in enamelled bricks that can attack the wires, but there seems to be some kind of cement or other used for attaching these enamelled bricks. We have had several cases of wires being completely eaten through.

Mr. George Broughall: The only point which I should like to mention is the price at which work is at present being put in. It appears to me that the lasting power of installations lies in the quality of the material which is put in, and it is to me wonderful, at prices which I know several installations have been put in, how they have passed inspection at all; of course, some of them may pass inspection when first installed and new, whereas perhaps in a few months they would not pass another inspection of the work. Then what about the consumers? Most likely they have to take out a portion of the work, if not all, and go to the expense of having it done over again. I think everything possible should be done to improve the quality of work, instead of bringing it down, as is the case at present with the low prices that are going. It seems to be the rule now-a-days to take the lowest tender, and cut down the prices. If good work is to be put in, I think a fair price ought to be paid.

Mr. A. Eckstein: I have just one thing to mention, and that is that Mr. Henderson seems to think that fittings manufacturers should do installation work, whilst cable manufacturers should not. Now, I think this is the other way about. He seems to think that the reason why fittings manufacturers ought to do installation work is because their clients cannot get fittings at reasonable prices. I think if any manufacturer does installation work it should only be on one supposition, and that is that more justice could be done to the quality of his manufactures by putting in the work himself, and not at all on account of price.

Mr. J. Conolly: With reference to the action of cement upon India-rubber, which was mentioned a little while back. I have heard very often of this, but have never seen any cable that has been affected in this way; if any gentleman has any samples by him, I should like very much to see them. I would try and find out the cause of the trouble. Mr. Eidsforth asked the reason why joints in electrical installations were not tested by immersion in water, the same as they are in telegraph work. I may say that I do not think this feasible at all; I think it is impossible to test a joint in a strange building with all the complexities of electrical fittings, &c., in the way. As a matter of fact, I think it is altogether out of the question. The main point is to try and improve the condition of the wiremen at present employed, and I quite agree with Mr. Henderson that, as a rule, he is entirely incompetent.

Mr. E. H. Nisbett: With the present method of house wiring, joints are undoubtedly a weak point, but I do not see that watertight joints can be made at all, and I do not think that any house joint could be tested under water, whether it was intended for a damp place or dry. Undoubtedly, with some of the joints that are put in at the present time there is to be trouble in future. If pure rubber only lasts a few years, and vulcanised rubber, say, 15 or 20 years, what is going to happen? What is the good of putting in wire to last 20 years, and putting in joints that will only last a tenth of that time? I think it is for the vulcanised cable manufacturers to advise something, and help out the contractors in this matter. We are thinking of doing something very shortly in the matter of lead-covered cable for house wiring.

Mr. Fawcus: Has any gentleman present had any experience with Andrews's system of concentric wiring?

Mr. Nisbett: I saw something of it when I was second engineer to the City Company on several installations, and there are one or two points that are, perhaps, worthy of attention. One is that owing to the iron return in Andrews's system, the self-induction with alternating currents is very great, and the resistance of the return conductors is in consequence very much higher. Mr. Nisbett then went on to criticise one or two more points of Andrews's system.

Mr. Broughall: I should like to mention one other point, and that is that as the weak points in installations are apparently in the joints, I think the number of joints should be reduced as far as possible, and I quite agree with Mr. Henderson that the only way to do this is to run the wires back to distributing boards. This may cost a little more money in the first instance, but, at the same time, I think it would be a great saving in the long run.

Mr. Andrew: May I make a suggestion to the effect that if periodical inspection were made to electrical installations the trouble might be very much reduced, as it seems to me that if the contractor had in his mind the possibility of his installation being inspected at any time he would probably be more careful in putting in good work in the first instance.

Mr. Henderson, in replying to the foregoing remarks, said:—

Mr. Eidsforth has suggested that in his opinion joints should be immersed in water for testing purposes. This would undoubtedly be a very good thing if it could be done, but for house work it is almost an impossibility. I am afraid that very few joints at present made would stand any test of the kind at all; the obvious thing to do is to vulcanise the joints, and I am given to understand that a very simple and expeditious method of vulcanising joints has lately been brought out. It is undoubtedly a very important point, as joints certainly have more to do with bringing down the insulation resistance than anything else.

Mr. Claremont said something about the price of fittings, which I did not quite catch. I think he said that manufacturers of fittings should supply them at a moderate price, provided they took care to allow trade discount, but I think there are very few firms who allow trade discount to private individuals; perhaps there are a few exceptions.

Mr. Wooler has made reference to the amount of current used at the Free Trade Hall, but I think I am right in saying that with regard to the Free Trade Hall there is an actual saving of current through having adopted the five-wire system; probably the reason why the Free Trade Hall seems to consume more current than it should, is because it was never properly metered. It was metered in earlier days by two Thomson meters on the outers, which was practically of no use whatever. Now, a five-wire meter has been adopted, but this does not seem to be of any practical use, as it seems to register whether the lamps are being burnt or not.

Mr. Thomas alluded to the action of cement on rubber insulating, material: I think that it is perhaps not altogether the action of cement; I think you would find that you got the same result if you embedded the wire in any kind of plaster or concrete, or anything else of the kind; very often it is due to the electrolytic action through exposure to moisture.

Mr. Fawcus has asked for instances of corrosion with enamelled bricks. I have a very vivid case before me where we had a meter which got an earth leakage, that is to say, we got 200 volts to earth. The meter was fixed on a pine board, and the board was fixed on enamelled bricks. It had been fixed some six or eight months, with probably an average current of 1½ to 2 ampères leakage to earth, and when we came to inspect it we found the board almost destroyed, and behind the board, when taken down, we found that the glazed surface of the bricks was entirely destroyed and broken up, and just the ordinary brick surface left beneath.

Mr. Broughall has made some allusions to the price at which work is going. I think he said that a fair price ought to be paid for fair work, and this is quite right; but I am afraid we have many contractors who put in good work and good material, but at ridiculous prices, obviously in order to get established.

Mr. Eckstein has said that cable manufacturers should do installation work in preference to fittings manufacturers. Considering that two-thirds of the capital outlay goes in any case to the cable-maker, I think it is only fair that the fittings maker should be in a position to pull back something on the one-third that is his share.

Mr. Conolly spoke of improving the condition of the wiremen, amongst other things, and this I consider a most important point. Why not have schools, &c., for teaching the work, and then we might possibly be able to get hold of some really qualified men. His other remarks I have already spoken about.

I quite agree with Mr. Andrew's remarks with regard to periodical inspections, and in future, in Manchester, this will be carried into effect, I believe. Once in six months each installation in the town will be inspected, tested, and a record kept of anything broken down, insulation resistances, &c.

The Chairman (Mr. Fawcus): I am sure that we have obtained some good from Mr. Henderson's paper, although I had hoped for a rather more animated discussion upon some of the points than we have had. One or two things have been brought out which are undoubtedly of importance, but I consider that one of the most important probably is (to contractors at all events) the low prices at which work is going at the present time. We are constantly hearing of jobs being taken, mostly by young firms who are endeavouring to get established, as Mr. Henderson said, at prices at which it is simply impossible to make it pay. I think we should all endeavour to keep prices up as much as possible; if a man is not pinched in prices, he is not likely to get any bad work. As to the question of joints; of course, we cannot help getting any number of bad joints in the best installations, as we cannot possibly follow wiremen through every joint that is made, and if we are pushed, as Mr. Henderson mentioned, we are bound to reduce practically our supervision, as we have got more men on, and we have to take men on, some of whom we know nothing at all about. This probably is the most fruitful cause of bad joints. I quite see Mr. Nisbett's point as to the uselessness of vulcanised rubber if we make pure rubber joints; but, of course, in house work it is impossible to carry fire about the place. Until we get higher prices, we can hardly hope for these refinements in workmanship. In conclusion, I would like to move a very hearty vote of thanks to Mr. Henderson for his very interesting paper.

Mr. Henderson: I hoped to have had a little more discussion on the subject, but, nevertheless, I would just like to add that with regard to the system of vulcanised joints for houses, Mr. Fawcus said that it would be impossible to carry fire about on installation work; but I think the new process I spoke about does away with this entirely. I believe it is not necessary to have any heat. I presume we shall be hearing more of it in the electrical papers; if it can be brought to any state of perfection it will, no doubt, be a very good thing.

NEW PATENTS 1894.

21,185. "Improvements in oil, gas, electric, and other light pendants." C. T. Powell. Dated November 5th.

21,202. "An electrical type-writer." G. C. Walker and T. S. Paynter. Dated November 5th.

21,218. "Improvements in electrical switches." C. P. Ehmann. Dated November 5th.

21,244. "Apparatus for electrically signalling from the locomotive to the carriages of a railway train." M. Z. Levy. Dated November 5th.

21,250. "Improvements in or relating to multiple telegraphic apparatus." A. Piedfort. Dated November 5th. (*Complete.*)

21,323. "Improvements in apparatus for welding electrically." W. P. Thompson. (Communicated by C. L. Coffin, United States.) Dated November 6th. (*Complete.*)

21,330. "Improvements in galvanic batteries." G. Hubner. Dated November 6th. (*Complete.*)

21,347. "Improvements in systems of telegraphic or telephonic exchanges." W. Childs. "Dated November 6th. (*Complete*).

21,353. "Improvements in electric motors for railway vehicles." H. S. Park. Dated November 6th. (*Complete.*)

21,366. "Improvements in connection with electrically propelled vehicles for running on ordinary roads." F. King. Dated November 6th.

21,367. "Improvements relating to the connections of battery receptacles employed in electrically propelled vehicles." F. King. Dated November 6th.

21,410. "Improvements in and connected with electrical apparatus for signalling on railways." W. J. Rawson. Dated November 7th.

21,439. "Electrical sewer ventilator." E. M. Lacey. Dated November 7th.

21,446. "Improvements in electric meters." C. J. Barley. Dated November 7th.

21,452. "Improvements in automatic electric fire alarms and signals." P. R. J. Willis. (Communicated by L. A. Werner and C. J. Werner, United States.) Dated November 7th.

21,461. "Electric motors." C. Riordon. Dated November 7th. (*Complete.*)

21,482. "Improvements in recording apparatus for ships' telegraphs." E. Fletcher. Dated November 8th.

21,489. "An electric track machine for railway system. E. Deming. Dated November 8th. (*Complete.*)

21,531. "Improved electric sash balance." W. C. Hodgkins. Dated November 8th.

21,549. "Improvements in electrically heated robes, towels, quilts, and other articles of flexible fabric." H. G. O'Neill and E. Jewell. Dated November 8th. (*Complete.*)

21,555. "Improvements in secondary batteries." I. A. Timmis. Dated November 9th.

21,613. "Improvements in telephones." E. C. Parker. Dated November 9th.

21,629. "Improvements in and relating to electric railways." L. Hanisch and the Hoerder Bergwerks and Hutten-Verein. Dated November 9th. (*Complete.*)

21,630. "Improvements in electric meters." H. Leupold. (Communicated by H. Leupold, Italy.) Dated November 9th.

21,640. "Improvements in or connected with electric switches." G. J. Gubl. Dated November 9th.

21,684. "Automatic hydro-electric indicator and alarm." H. Dando. (Communicated by H. A. Dando, New Zealand.) Dated November 10th.

21,707. "Improvements connected with the electric conductors of electric railways." A. Slater. (Communicated by J. Platt, United States.) Dated November 10th. (*Complete.*)

21,731. "Improvements in arc lamps." C. A. Day. (Communicated by G. J. Schoeffel, United States.) Dated November 10th. (*Complete.*)

21,750. "Improvements in arc lamps." J. W. Rogers. Dated November 10th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

15,971. "Electro-magnetic motor for maintaining uniform speed." G. L. Anders and W. Kottgen. Dated August 24th. Consists of a ball of metal which rolls upon a disc, pivoted at the centre, actuated by electro-magnets, so as to cause the disc to be depressed slightly in advance of the rolling ball, thereby keeping up a continuous and uniform circular movement of the ball so long as the current passes through the electro-magnets. 2 claims.

21,435. "Contact device or circuit connection for electric heating bodies and analogous electrical appliances." F. W. Schindler. Dated November 10th. Relates to a three-pole plug contact device consisting of two principal parts, one of which carries three parallel plugs or contact pins, while the other contains three corresponding sockets lined with metal bushes. One of the two parts, that is, either the plug piece or the socket piece, is electrically connected with the source of electricity, while the other part is electrically connected with the heating body. 3 claims.

21,966. "An improved electrical drop indicator." E. Beal. Dated November 17th. Claim:—An electrical drop indicator, substantially as described, in which the drop piece is released by a loose core being drawn into a bobbin of wire, either as a solenoid, or with another core in the bobbin.

22,519. "Improvements in clips for electric conductor casings." C. Dabrah and C. C. Metcalfe. Dated November 24th. The clip constructed according to these improvements consists in its simplest form of a strip of spring metal such as hoop steel bent to a U-form, of which the curved part may be bent or enlarged for the insertion of a finger. The two arms of the clip normally tend to approach each other more closely than the thickness of the casing with which it is to be used. The body of the casing having been fixed and the wire or wires inserted therein, one limb of the clip is passed between the casing and the wall or ceiling to which it may be fixed, when the other limb of the clip comes over the wire or wires and prevents its accidental removal. 1 claim.

22,960. "Improvements in or relating to the method and means employed for controlling electrical devices from a distance." H. W. Wilkinson and L. Penson. Dated November 29th. Relates to the use of fluid pressure, acting upon a piston in a cylinder, for operating from a distance electric current switches, or devices of a like nature, instead of the electric current force; this fluid pressure is transmitted from a central or sub-station, or other suitable and remote place, through one or more pipes to the said cylinder and piston, and the mechanical motion of the piston is used to actuate the switch device. 4 claims.

23,239. "Improvements in connection with arc lamps." F. M. Lewis. Dated December 4th. Has for its object to ensure great regularity in the feed as the carbons are consumed, to effect this with very small variation of the electromotive-force across the terminal of the lamp, and to ensure greater certainty of the striking of the arc. 6 claims.

23,308. "Improvements in continuous current dynamos, either for generating or for receiving electric currents." M. Hutin and M. Leblanc. Dated December 4th. The dynamo is constructed either with a fixed armature while the field magnets revolve within this armature, or the reverse arrangement may be employed. 2 claims.

1894.

2,866. "Improvements in and having relation to dynamo-electric machines." W. L. Wise. (A communication from abroad by I. N. Lewis, of New York.) Dated February 9th. Consists in a method of automatically regulating a dynamo machine to deliver a substantially constant potential irrespective of the speed by increasing the strength of a current which cuts down the field magnetism with an increase of speed and *vice versa*, thereby automatically regulating the voltage so that any tendency to increase thereof with increase of speed will be practically compensated for by the decrease of the magnetic field. 1 claim.

6,491. "Improvements in and apparatus for converting electric currents." S. Pitt. (Communicated from abroad by A. Blondel and Sautter, Harle et Cie., of Paris.) Dated March 31st. The apparatus is characterised by the combination of a revolving closed magnetic circuit free from leakage, with a special arrangement of rotating brushes and means for withdrawing and automatically adjusting these brushes. 9 claims.